AFHRL-TR-80-48(I)

LEVEL II

(12)

# AIR FORCE HUMAN RESOURCES LABORATORY

AD A098849

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INSTRUCTOR-SIMULATOR INTERFACE DESIGN

By


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Williams Air Force Base, Arizona 85224


April 1981

Final Report

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AIR FORCE SYSTEMS COMMAND
BROOKS AIR FORCE BASE, TEXAS 78235

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This report was submitted by CAE Electronics Ltd., P.O. Box 1800, Saint-Laurent, Montreal, Quebec, Canada H4L 4X4, under Contract F33615-78-C-0006, Project 6114, with the Operations Training Division, Air Force Human Resources Laboratory (AFSC), Williams Air Force Base, Arizona 85224. Lt Franklin D. Cooper and Maj David L. Pohlman were the Contract Monitors for the Laboratory.

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

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Commander

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

| REPORT DOCUMENTATION PAGE | | READ INSTRUCTIONS BEFORE COMPLETING FORM |
|---|---|---|
| 1. REPORT NUMBER AFHRL-TR-80-48(I) | 2. GOVT ACCESSION NO. AD-A098 849 | 3. RECIPIENT'S CATALOG NUMBER |
| 4. TITLE (and Subtitle) INSTRUCTOR-SIMULATOR INTERFACE DESIGN | | 5. TYPE OF REPORT & PERIOD COVERED Final rept. |
| | | 6. PERFORMING ORG. REPORT NUMBER |
| 7. AUTHOR(s) | | 8. CONTRACT OR GRANT NUMBER(s) F33615-78-C-0006 -new |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS CAE Electronics Ltd. P.O. Box 1800, Saint-Laurent Montreal, Quebec Canada H4L 4X4 | | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 62205F 61142307 |
| 11. CONTROLLING OFFICE NAME AND ADDRESS HQ Air Force Human Resources Laboratory (AFSC) Brooks Air Force Base, Texas 78235 | | 12. REPORT DATE April 1981 |
| | | 13. NUMBER OF PAGES 216 |
| 14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Operations Training Division Air Force Human Resources Laboratory Williams Air Force Base, Arizona 85224 | | 15. SECURITY CLASS. (of this report) Unclassified |
| | | 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE |

18 6 9 15 16 12 227 17 23 11 407 421

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

computer analysis
computer-assisted evaluation
decision making
flight simulator
instructor/operator station
network modelling

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Most flight simulators in service today are operated from instructor stations where design requirements have been established by subjective opinion, past experience, and space and equipment constraints. In contrast, crew stations of simulators, being replicas of aircraft crew compartments, reflect painstaking, systematic efforts in human engineering and pilot evaluation. To improve the overall quality of simulation, then, efforts should be directed at improving the efficiency and operability of instructor facilities. The objective of this study is to develop a method of evaluating the degree to which an instructor/operator station (IOS) design bridges the gap between human characteristics and machine requirements. An objective evaluation methodology should assist the designer in assessing a tentative IOS design by identifying devices and functions responsible for poor system performance. A secondary objective of the study was to apply this tool to evaluate the effectiveness of various interface layouts and

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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devices. The primary purpose of this report is to describe the development, test, and application of a computer-assisted evaluation technique which resulted from this study.

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# 1. EXECUTIVE SUMMARY

1.1 Introduction. Most flight simulators in service today are operated from instructor stations where design requirements have been established by subjective opinion, past experience, and space and equipment constraints. In contrast, crew stations of simulators, being replicas of aircraft crew compartments, reflect painstaking, systematic efforts in human engineering and pilot evaluation. To improve the overall quality of simulation, then, efforts should be directed at improving the efficiency and operability of instructor facilities.

The objective of this study is to develop a method of evaluating the degree to which an instructor/operator station (IOS) design bridges the gap between human characteristics and machine requirements. An objective evaluation methodology should assist the designer in assessing a tentative IOS design by identifying devices and functions responsible for poor system performance. A secondary objective of the study was to apply this tool to evaluate the effectiveness of various interface layouts and devices.

The primary purpose of this report is to describe the development, test, and application of a computer-assisted evaluation technique which resulted from this study.

1.2 Approach. The IOS is the man-machine system which permits an instructor to utilize a simulator and, in particular, its computer in the instruction and evaluation of a trainee. The IOS establishes the compatibility between the following:

(a) The exigencies of training objectives and instructional tasks

(b) The skills, characteristics and limitations of the instructor

(c) The functions, characteristics and limitations of the computer.

The basis for the suitability evaluation of an IOS was defined as the time required for an operator to perform an instructional task. This measure is valid only if the task is feasible with the equipment provided. In addition, the measure is meaningful only if the instructor performs the task correctly.

These objectives were realized through the following steps:

(a) Delineation of the instructional tasks and activities.

(b) Consideration of man-machine interface factors.

(c) Construction of a typical sequence of instructional tasks or a representative task profile (RTP).

(d) Definition of typical instructor tasks or activities and a breakdown of those tasks in terms of units of time required for completion.

(e) Construction of a process to yield a quantitative evaluation of an IOS design.

(f) Validation of that process through comparison with empirical data.

(g) Demonstration of the utility and practicality of the evaluation method by the general user.

In carrying out these steps, building blocks were developed including an Instructional Task List, Representative Task Profile, and Typical Activity Modules. These were compatible with SAINT, the computer analysis package used.

1.2.1 Instructional Task List. A list of the activities required to prepare and conduct a training flight was developed from lesson plans prepared for the United States, West German, and Canadian Armed Forces. The resulting Instructional Task List (ITL) provides the designer/evaluator with a list of these typical tasks. Any mission can be constructed by selecting a suitable sequence from the ITL (a typical task is ARRANGE MAPPING DISPLAYS).

1.2.2 Representative Task Profile. A typical training mission, including a wide variety of instructional tasks and assembled with a reasonable sequence of items selected from the ITL, was defined as an RTP. This RTP definition was useful in evaluating the suitability of alternate IOS designs to the tasks the instructor must perform in a training exercise. Instructive activities (such as the assessment of trainee performance) were included in the ITL and, hence, in the RTP since they are dependent on information presented to the instructor by the IOS. Thus, the method of their presentation was one factor to be evaluated.

1.2.3 Typical Activity Modules. Through analysis of the RTP, repetitive sequences of tasks could be identified and grouped. For example, the RTP task ARRANGE MAPPING DISPLAYS was divided into groups of tasks such as read, display, etc. These groups of tasks were defined as typical activity modules (TAMs).

1.2.4 SAINT. An existing network and modelling program, SAINT (systems analysis of integrated network of tasks), was selected as a ready-made and convenient tool to form the model of the IOS interface. SAINT was developed at the Aerospace Medical Research Laboratory, Wright-Patterson AFB, Ohio, to model, in network form, sets of tasks performed during the course of a mission. SAINT obtains mission performance measures for networks which represent a mission consisting of a set of tasks performed by a crew of operators.

A computer simulation approach is used to obtain the performance measures. Human engineering considerations are included through parameters associated with tasks, precedence relations between tasks, and factors affecting crew performance. The network simulates the events of the TAMs and generates time performance data. These data can then be used to model the tasks of the RTP, predicting overall performance for segments of the training mission. The model is completely adjustable through parameter sets defining tasks. The network structure is such that interactive effects between tasks and workload

are evaluated by iteration of the model and not be the arbitrary inputs of the user.

By this approach, and due to the use of an active computer model, two phases of evaluation became available. The data obtained from the TAMs yield information as to the suitability of a device to have a task performed on it. The data obtained from SAINT, when modelling the RTP, yield information as to the suitability of the entire IOS (of which the interface is a part) to the running of a flight training mission.

1.3 Evaluation Methodology. For this study to be effective, an evaluation methodology was required which did not rely on a high level of programming expertise on the part of the user. To achieve this goal, each part of the descriptive chain formed by the RTP and TAMs was implemented in a standardized format.

The RTP was formed as a standard training mission. Running the RTP with SAINT with the parameters chosen for the IOS in question yields a quantitative description of the IOS. The TAMs have been structured to include as many as possible of the actions normally performed by an instructor. The user chooses the actions applicable to the IOS under evaluation. The TAMs are supplied to the user in standardized form. SAINT provides the ability to designate tasks in a network as dormant by defining the time required to perform the task as zero. Thus, the user need only choose an appropriate TAM, designate the unnecessary tasks as dormant, and choose from the supplied index of parameter sets the parameters which best describe the tasks as performed on the candidate IOS. These data can easily be inserted into the data files supplied for each TAM. The TAMs can now be run by SAINT.

The data supplied by the TAMs are then used to evaluate instructor tasks within the RTP. As with the TAMs, the RTP is supplied to the user fully constructed and with its data file.

The user is supplied with standard forms for each TAM and each portion of the RTP mission. The user need only choose the appropriate parameter set (from the parameter set index) which best describes the interface in question, and run the descriptive networks with those data to obtain a detailed analysis of the IOS design being evaluated.

1.4 Conclusions. The evaluation methodology proved to be an efficient and easy to use procedure with which to evaluate the design of an IOS. SAINT displayed a very high sensitivity to small variations in the data, and therefore to small differences in IOS design.

The descriptive chain, made up of the RTP, ITD (instructor task description) and TAMs, was arranged in a checklist form by which the user could easily choose those characteristics pertinent to the IOS being evaluated or designed. The parameters sets necessary to supply the times required for each instructor set could easily be inserted into the supplied data files for each portion of the RTP and each TAM.

## 1.4 Conclusions (Cont'd)

The model was validated by choosing a particular task in the RTP and varying the parameters associated with it (i.e., time required for the task, operator speed, accuracy, and stress threshold). The results of these variations were reflected in the number of successful missions, times for completion of the missions, and average stress levels on the operators. The model, and the SAINT program, proved to be very sensitive to these data perturbations.

This validated methodology was then used to evaluate two designs of the IOS for a typical jet fighter trainer. Both designs contained the same hardware, but the hardware configuration differed. By adjusting the model of the RTP to fit both the configurations (#1 and #2) and running the data on SAINT, it was determined which configuration was more advantageous to the running of a training mission.

The methodology was then used to evaluate three candidate interface techniques. It was here that the sensitivity of the model to data perturbations was rigorously tested. A task was designated to be performed on a particular interface device. When different interface devices were implemented on an IOS, although these devices may be used as infrequently as twice per leg of the RTP, different numbers of successful missions, different times of completion and different stress levels were reported by the software.

To summarize, the developed methodology proved to be easy to implement, highly sensitive, and precise. As more ergonomic data are found to quantify the instructor activities, the model will become more accurate. In general, the model can be used to select components, evaluate layout and indicate the acceptability of IOS designs.

# 2. INTRODUCTION

2.1 Study Objectives. Technology exists today whereby training objectives can be achieved through automatic training and performance evaluation. Automation has obvious advantages, such as uniformity of training and elimination of instructor bias; however, most investigators and users find that positive instructor control and involvement in a training exercise are essential factors of objective and complete training. Hence, the main goal of this study was to establish a systematic process to aid in the evaluation and design of instructor/operator stations. This goal introduces the need for a systematic division of tasks between the instructor and the man-machine interface.

2.1.1 Interface. The main responsibility for a given activity may be assigned to either the man or the machine, but the training objectives and results in both cases remain the same. Only the levels and modalities of the interface change as the IOS designer attempts to balance functional flexibility and freedom of control against machine support to attain the desired system performance at an acceptable instructor workload. The choice and arrangement of controls, together with the associated software and hardware functions, comprise the IOS man-machine interface.

2.2 Approach to Meeting Study Objectives. The study first required a systematic review and delineation of instructional tasks (e.g., insert lesson plan, set up scenario) and an explanation of the factors intrusive on their performance.

The establishment of an objective method to evaluate the suitability of the interface to typical IOS tasks in quantitative terms was the second step in the approach.

The final step was the development of a means to predict man-machine system performance of a given IOS design for a profile of representative tasks.

2.2.1 Nature of Instructor Tasks. Based on experience with flight simulators and lesson plans prepared for the United States, West German, and Canadian Armed Forces, a list of activities required to prepare and conduct a training flight was developed. This ITL, Figure 2-1, provided a systematic breakdown of the overall training objectives into their component steps.

2.2.1.1 Pacing. In preparing the ITL, potential pacing sources for each of the tasks were identified as follows:

(a) Instructor: free choice as to time of activity

(b) Simulation: timing determined by the progress of the simulated flight

(c) Trainee: activity demanded by particular needs of the trainee based on trainee's long term training status and performance

## INSTRUCTIONAL TASK LIST

| TASK NO. | DESCRIPTION | PACING SOURCE | | | | | | | NATURE | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | LP | IN | TP | TS | SN | NS | MT | P | D | R | E |
| 3.8 | - Malfunctions | | | | | | | | | | | |
| 3.8.1 | - Designate preselect malfunction | X | X | X | X | | | | | X | | |
| 3.8.2 | - Specify criteria for preselect malfunction | | X | X | X | | | | | X | | |
| 3.8.3 | - Arm malfunction | X | X | | | | | | | X | | |
| 3.8.4 | - Insert discrete malfunction | | X | X | X | | | | | X | | |
| 3.8.5 | - Insert variable malfunction | | X | X | X | | | | X | | | |
| 3.8.6 | - Reset all malfunctions | | X | | | | | | | X | | |
| 3.8.7 | - Cancel discrete malfunction | | | | | | | | | | | |
| 3.8.8 | - Cancel variable malfunction | | | | | | | | | | | |
| 3.9 | - Radio Facilities | | | | | | | | | | | |
| 3.9.1 | - Fail Radio Facility | | | | | | | | | | | |
| 3.9.2 | - Reset all failed radio facilities | | X | | | | | | | X | | |
| 3.9.3 | - Verify tuned Radio facility | | | | | | | | | | | |
| 3.9.4 | - Set up portable radio facility | | | | | | | | | | | |

Figure 2-1 Typical ITL Page
(the entire ITL is available in Appendix A)

(d) Equipment: method of command input determined basic task time

(e) Lesson: timing determined by the unit sequence to completion of a lesson

(f) Indirect simulation: summary interpretation, monitoring activity dictates timing

(g) Maintenance: requisites of maintenance program determine timing (as in liaison with maintenance personnel).

2.2.1.2 Tasks. A typical training mission representing a wide variety of instructional tasks was assembled with a reasonable sequence of items selected from the ITL. This Representative Task Profile (RTP), Figure 2-2, is a sequence of instructor activities performed on an IOS (e.g., ACTIVATE MALFUNCTION). This breakdown was to evaluate the suitability of an IOS design to the activities or tasks the instructor performed in a training mission.

2.2.1.2.1 Task Building Blocks. Assuming a conventional complement of IOS displays and controls, the tasks of the RTP could be broken down into basic building blocks as follows:

(a) Spotting the change in displays

(b) Evaluating the significance of that change

(c) Deciding on the required response

(d) Executing an input if required

(e) Monitoring the resulting machine response.

This breakdown of the RTP tasks resulted in a set of 19 descriptors which cover all the tasks in the RTP. These descriptors (e.g., ASSESS CREW COOPERATION, DISPLAY MANAGEMENT) comprise the title components of the Instructor Task Description (ITD) List (Appendix C) (see Figure 2-3).

2.2.1.2.2 Task Categories. Upon examination of the items within the ITD, it was found that three basic categories of tasks exist. These are as follows:

(a) Operation Tasks

(1) Activating manual controls or otherwise making inputs to elicit simulator functions necessary to conduct the training

(2) Participating in the simulation by making inputs representing the outputs of external sources (e.g., radio messages)

(3) Effecting changes such as deviating from a preprogrammed sequence or set of simulated conditions.

IOSS REPRESENTATIVE TASK PROFILE

| | | ITL | LVDU | RVDU |
|---|---|---|---|---|
| 7.0 | ROLL-IN & SHUTDOWN | | | |
| 7.1 | Shutdown Checklist Procedures | | P 50 | |
| 7.1.1 | Call Up Crew Activity Monitor Display | | P 50 | |
| 7.1.2 | Assess Sequence of Discrete Crew Activity | 4.2.1 | | |
| | Monitor Shutdown Procedure Checklist Activity | | P 50 | |
| 7.1.3 | Assess Crew Cooperation | 4.2.4 | | |
| | Monitor Intercomm Exchanges | | | |
| | Monitor CAM Display on line | | | |
| 7.2 | Post-landing Debrief | | | |
| 7.2.1 | Apply TOTAL FREEZE | 3.7.1 | | |
| 7.2.2 | Debrief Crew | 5.1.5 | | |
| | Use CAM Records | | P 50 | |
| | Use MAP | | | MAP |
| | Use written notes | | | |

Figure 2-2 Typical RTP Page
(the entire RTP is available in Appendix B)

| INSTRUCTOR TASK DESCRIPTION | | A | D | IOS ACTIVITIES |
|---|---|---|---|---|
| CRITIQUE CREW PERFORMANCE | | | | |
| | 67 | | | |
| Interrupt simulated flight and training problem | 68 | / | | Apply TOTAL FREEZE |
| Obtain performance data on problem just completed | 69 | / | | Read CAM display page |
| | 70 | | | Scan Mapping Display |
| | 71 | | | Graphic Plcts |
| Compare performance data to desired performance indices | 72 | / | | Read procedure/performance standards |
| Perform critique immediate feedback to trainee crew | 73 | / | | Use Intercomm |
| | 74 | / | | Use notes |
| | 75 | / | | Cognitive |
| | 76 | | | |

Figure 2-3 Typical ITD Page
(the entire ITD listing is available in Appendix C)

(b) Instruction Tasks

(1) Monitoring trainee performance and techniques

(2) Formal assessment of trainee proficiency and performance

(3) Coaching, remedial comments, and demonstrations.

(c) Documentation Tasks

(1) Recording data for performance evaluation

(2) Making written notes.

This categorization aided in determining which particular aspects of the IOS could be evaluated. All operational tasks and the documentation task of recording data are subject to evaluation because they can be performed on a variety of interface hardware. The location of the interface devices, as well as the type of interface device, can affect the efficiency with which a task may be performed. The instructional task of monitoring trainee performance can also be evaluated because the ability to monitor performance depends on the manner in which this information is presented to the instructor (i.e., interface methods).

Not only were the tasks listed, but the step by step procedures required to perform a task were incorporated in the ITD. These elements of the ITD were described, in terms of how they were performed, in the IOS Activities List (also included in Appendix C) (refer to Figure 2-3). For example, an ITD item may read "Verify against standard procedure." The IOS activity will describe how that is done, in this case, "Read procedure checklist."

The procedures set forth in the IOS Activity List are further resolved into the step by step actions required to carry out a task on a particular interface device. These procedures (Figure 2-4) were arranged into Typical Activity Modules (TAMs). The TAMs were written to describe the performance of operation tasks on various interface devices. A TAM describes a typical instructor/IOS activity in detail sufficient to match most task requirements to most IOS configurations by simply selecting the appropriate TAM, thus avoiding need for individual analysis. This was the final step in the resolution of instructor tasks.

2.2.2 Analysis by Subsystems. Instructor activities involve many physical and subjective factors and conditions. Success or failure in achieving desired system performance depends on complex interactions between the skills and limitations inherent in the human operator, the capabilities and functions of machine elements toward training problem presentation, trainee evaluation and instructor facilities, and the requirements of instructional task activities, as in representing the required sequence of events, pacing functions and trainee evaluation results. This grouping suggests three inter-

READ "PRINTED TEXT" TAM 1

A D

1 Attention-Getter

2 Retrieve Material

10 Visually Access

40 IPTASK

3 Display Delay

50 Information Type I
51 Information Type II
52 Information Type III
53 Information Type IV

60 Read (Type I)
61 Read (Type II)
62 Read (Type III)
63 Read (Type IV)

Figure 2-4 Typical Page from the TAM Library
(the entire TAM listing is available in Appendix F)

connected, but essentially dependent categories or subsystems.

When these interfaces are compatible, the resulting continuous system will be amenable to analysis in terms of individual subsystem performance without detailed knowledge of the processes internal to the subsystems.

2.2.2.1 Man and Machine Subsystems. The human is inherently incompatible with the machine because speed and language differences generate gaps between the human sensory and neuromotor skills and the machine input/output capabilities. It is the IOS interface methodology which must provide appropriate matching functions and establish continuity and compatibility. In this context, the IOS design parameters could be defined in terms of these matching functions, and evaluation would consist of testing the available IOS functions against them. As discussed later, this capability certainly exists in the evaluation methodology developed in this study, but a mature data base is required before reliable and repeatable results can be expected for the many task/interface combinations possible. Meanwhile, the reverse process is applicable, whereby various IOS devices can be selected and tested for suitability against typical or selected tasks, the entire IOS design and man-machine performance can be assessed against a representative task profile.

The principal contributions of the human, as applicable to this analysis, are:

(a) Sensory skills and perception

(b) Cognitive skills, pattern recognition, long- and short-term memory

(c) Decision making ability, assessment of intangibles

(d) Neuromuscular skills, complex motor performance.

Compared with machine functions, these represent highly complex capabilities in areas such as pattern recognition, as well as limitations in others, for example, low reliability of short-term memory and relatively low speed in most functions. Furthermore, human performance may be significantly altered by factors related to dynamic task conditions, such as workload and fatigue. Since these influences may assist, as well as inhibit, human performance and since they may be viewed as products of the task subsystem, we decided to declare the basic human contributions constant, but vary the "cost of performance" with the overall task profile. This stipulation permits the application of ergonomic performance data to estimate the time required to do elemental tasks using a selected IOS interface method or device. The actual time is then the product of the basic time plus factors derived from dynamic task conditions.

2.2.2.2 Task Subsystem. The main output of the task subsystem is the sequencing and pacing of the events required to achieve the training objectives. The pacing of activities has a decisive impact on the scheme of man-machine task allocation and therefore on the IOS interface methodology. For the present purposes, instructional tasks and training objectives are considered fixed and unalterable. The RTP may be performed by using different IOS devices and functions, but omission of any task constitutes a failure to attain required system performance.

2.2.3 Use of Computer Based Model/SAINT. A number of pencil-and-paper methods based on elemental logic, statistics, and queuing theory are available to analyze the interaction of tasks and activities. Link diagrams establish the strength of correlation between two work stations and thereby the necessity to walk from one to the other.[1] The Petrie Network method consists of two types of elements: places and transitions, connected by directed edges or arcs.[2] Tokens are used to indicate that all conditions (places) have been fulfilled to fire a transition (start an activity). The execution of a task uses up the tokens. Due to the complexity of the tasks in IOS evaluation, it became evident during the preliminary study phase that a more powerful tool would be needed and that the SAINT computer model developed by the U.S.A.F. Aerospace Medical Research Laboratory was eminently suitable for the purpose.[3]

SAINT is a combined network modelling and simulator technique. SAINT was designed to model, in network form, sets of tasks performed during the course of a mission. A SAINT network consists of tasks which, when completed, can satisfy precedence requirements for other tasks. Operators flow throughout the network from task to task performing those tasks. SAINT tasks have input sides, descriptors and output sides associated with them.

2.2.3.1 SAINT Task Input. The input side of a task contains the number of predecessor tasks which must be completed before the task can be begun (released).

2.2.3.2 Task Descriptors. The task descriptors are the heart of the network. The time required to perform a task is characterized by a distribution type and a parameter set.

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[1] CULLINANE, T. Minimizing cost and effort in performing a link analysis. Human Factors, 1977, 19(a), 151-156.

[2] MISUNAS, D. Petri nets and speed independent design. Communications of the ACM, August 1973, Vol. 16, No. 8.

[3] PRITSKER, A., et al. SAINT: Systems Analysis of Integrated Network of Tasks. Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, 1974.

2.2.3.2.1 Distribution Types. Sampling can be performed from any of the following distribution types:

(a) Constant

(b) Normal

(c) Uniform

(d) Erlang

(e) Log normal

(f) Poisson

(g) Beta

(h) Gamma

(i) Triangular

(j) Beta fitted to three estimates

(k) Constant divided by a scale factor.

Parameter sets contain the mean, minimum and maximum times, and include the standard deviation associated with the distribution. Parameter sets are identified by a parameter set number. Operator characteristics also have an effect on task duration and these are discussed in paragraph 2.2.3.4.

2.2.3.2.2 Task Types. There are six possible task types in a SAINT network:

(a) Single operator: task performed by only one operator

(b) Joint operator: task performed by more than one operator

(c) Equipment: simulates a piece of equipment and has no operator

(d) Cyclic: task used to provide a delay time until a following task can start

(e) Either: task performed by either one of a set of specified operators

(f) Gap filler: task simulating an activity performed periodically when time allows.

2.2.3.2.3 Task Essentiality. Each task performed by an operator has a graded essentiality associated with it. Task essentiality is graded on a scale from zero to one, with one as essential. The effect of this essentiality is to permit the skipping of low essentiality tasks when the amount of

essential time remaining to the mission is insufficient to complete the network. Essential time is an estimate of that time required to perform the essential tasks remaining to the mission.

2.2.3.3 SAINT Output. The output side of a SAINT task represents a branching or decision operation. Following completion of a task, a selection is made as to which branches emanating from the task should be activated. SAINT's five branching types are:

(a) Deterministic: all branches emanating from the task are activated

(b) Probabilistic: each branch emanating from the task has an associated probability of being selected. Only one of the branches is selected, based on a number drawn from a zero-one distribution

(c) Modified probabilistic: this is the same as probabilistic branching except that the probabilities associated with the branches change by a specified amount each time the task is released

(d) Conditional "take first": the branches are ordered and each branch has a condition associated with it. The branch whose condition is met first is activated

(e) Conditional "take all": this is the same as conditional "take first" with the exception that all branches where conditions are met are activated.

2.2.3.4 Operator Characteristics. Operator characteristics are used in conjunction with the task oriented concepts to make a mission operator-specific, and modify the time required to perform a task, as follows:

(a) Speed: this factor allows for the simulation of operators who are faster or slower than an average operator.

(b) Accuracy: this factor allows for the simulation of operators who may be more accurate or less accurate than the average operator.

(c) Stress threshold: this factor is the value which, when exceeded, causes the operators' performance to degrade. The workload stress on an operator is the time pressure imposed by a discrepancy between the amount of work to be done and the time allowed to do it.

(d) Goal gradient: this factor introduces an increase in performance relative to the proximity of a goal or end point.

2.2.3.5 SAINT Analysis. SAINT performs its analysis in two parts: benchmark iteration and actual mission performance calculations. The benchmark runs obtain estimates of the time required for the operator to perform each task and, from this information, calculate the essential time remaining, the nonessential time, and the idle time. None of the operator characteristics outlined are used in benchmark calculations.

In the actual mission performance runs, SAINT provides estimates of the probability of successfully completing the mission, the times of completion, and the minimum, maximum and average stresses incurred.

2.2.3.6 Static Analysis - TAMs. Through SAINT's capabilities, every realistic approach to evaluation for design can be explored. The static division of elemental activities consists of the TAMs. TAMs model isolated functions with no regard to a lesson plan context, surrounding activities, or other TAMs. TAMs, by title, define an IOS activity (i.e., the utilization of IOS hardware) and describe the procedures necessary to carry out the activity.

These procedures are the basic human functions required in the use of a device (i.e., display, keyboard, switch, etc.). The basic functions are as follows:

(a) Visual Access

(b) Manual Access

(c) Activations

(d) Reads

(e) Decisions.

TAMs also contain basic functions of the hardware of the IOS. These functions are:

(f) Attention-getting

(g) Display delays

(h) Information presentation task (IPTASK) characteristics (i.e., intensity of display, contrast in display, clutter, etc.).

The interaction of the human and hardware factors, when a TAM is run by SAINT, comprise the static phase of the evaluation (i.e., the isolated performance of an isolated IOS activity on an interface device).

2.2.3.7 SAINT Dynamic Evaluation. The dynamic aspect of evaluation/design incorporates the static phase into a representative lesson plan as an integral part of the evaluation. The data obtained from running the TAM through SAINT (i.e., average time of mission completion and probability of success) are inserted into the RTP model. The TAMs now interact with other TAMs in this representative lesson plan. From this dynamic model, the effects of all aspects of the IOS, in conjunction with TAMs and the application of the IOS to the lesson plan, are set forth. The results of a TAM describing a particular device may indicate that, in itself, that device is more suitable than several others. However, when that TAM is placed into the main model, its suitability to the particular IOS may be less than desirable. For example, a dedicated push button to call up a CRT page is faster than a keyboard inser-

tion for the same page. Insertion of the push button TAM into the dynamic model, however, may indicate that because of the location of the push button and the number of times it may be accessed, it is not the more efficient device for that function on that IOS.

2.3 Summary. Figure 2-5 presents a graphic representation of the study approach. An instructional task list was compiled. ITL items were arranged to form a typical lesson plan (RTP). The tasks of that RTP were then subdivided into basic building blocks (e.g., READ, DISPLAY, EVALUATE) in the ITD. The actual method of performing the instructor tasks was expanded into the IOS Activities List. It is here that the distinction between operator-only tasks and machine-assisted tasks surfaces. The tasks performed on the IOS are described in terms of their most basic functions on a particular interface device in TAMs. Ergonomic data, quantifying the time durations to perform these basic functions, are assigned to the TAMs and are analyzed by SAINT to supply the static phase of the evaluation. The data obtained from the static phase are then used as input to the RTP model. SAINT's analysis of these data provides the user with the model performance data.

2.4 Document Structure. The main body of this study consists of four sections. Section 2 presents an overview of study objectives. Section 3 details the development of the objective evaluation methodology used in analyzing and evaluating the designs of IOSs. Candidate interface techniques, the approach to the analysis, the actual development of the evaluative model and the validation of this model are all dealt with in Section 3.

Section 4 applies the developed methodology to the evaluation of two off-board IOSs and to three candidate interface techniques.

Section 5 summarizes the model effectiveness and the benefits to the user and includes recommendations for further work.

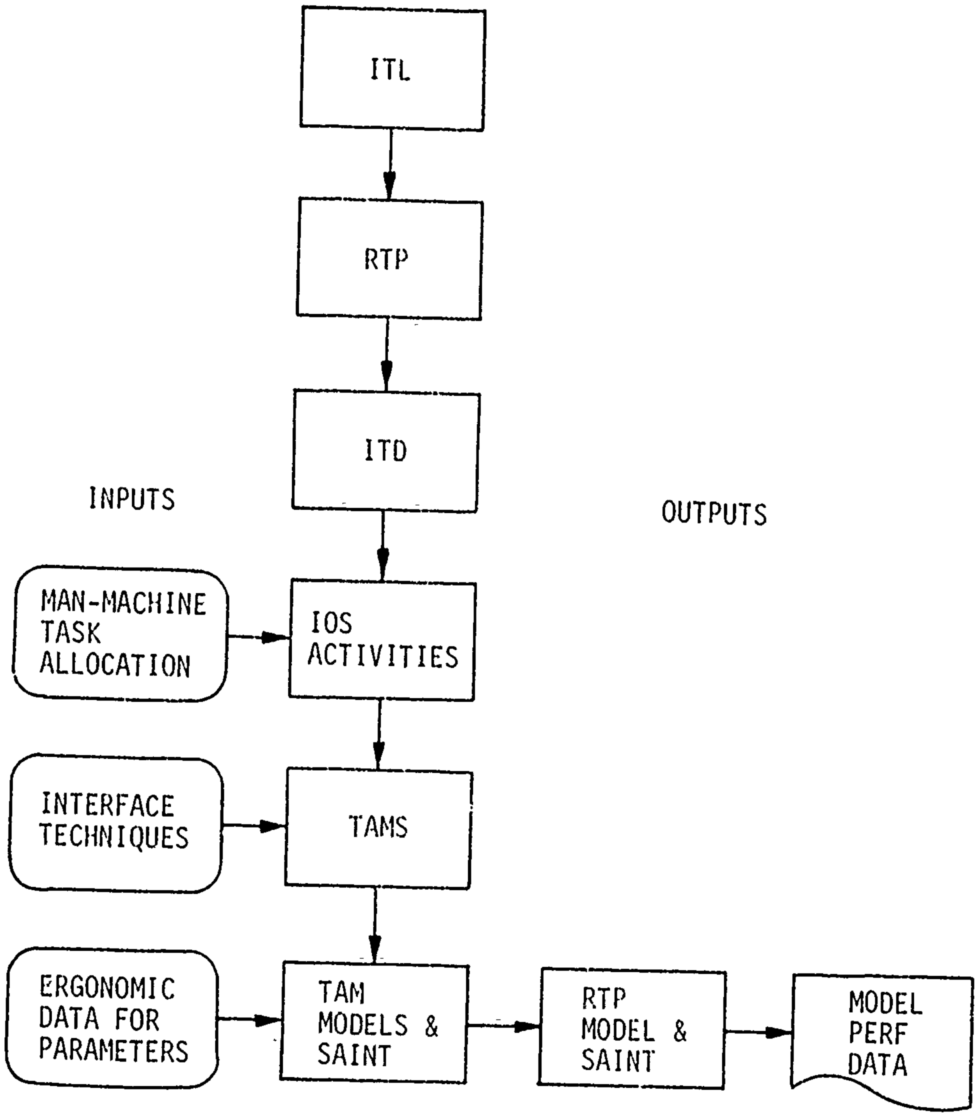


Figure 2-5 Evaluation Methodology Development (Graphically)

# 3. DEVELOPMENT OF OBJECTIVE EVALUATION METHODOLOGY

## 3.1 Candidate IOS Techniques

3.1.1 Introduction. The efficiency of the IOS determines the instructor/ operator workload and affects the success probability of a training session. Each interface technique or device should be designed for optimal man-machine interaction for specific tasks. The proper blend of techniques yields an efficient IOS. Some of the more common interface techniques are presented in this section, as well as some lesser known new technology devices. A brief description of devices operations is given and their advantages or disadvantages are exposed.

A survey of CAE simulators provided an initial list of candidate techniques which was extended by reviewing additional literature. Assessment of the applicability of a device to a specific task or group of tasks stems from a general knowledge of simulators and training, a data gathering trip (Appendix H), and other reference literature, particularly AFHRL-TR-77-10 and AFHRL-TR-77-50.

3.1.2 General and Specific Purpose Keyboards. The general purpose keyboard is a commercially available unit with an arrangement of keys in a standard typewriter configuration with no backlighting. Special purpose keyboards are available with optional backlighting. However, these tend to be costly and, in general, only simple matrix configurations can be purchased.

For the purpose of modelling, both the standard typewriter arrangement and a special purpose keyboard are considered together. These are input devices, usually operating in conjunction with a CRT (which provides feedback). They are used for tasks requiring alphanumeric input, examples of which might be selecting a new CRT display format, selecting a particular item on a CRT for input, or specifying a new value for a system parameter.

Unless a requirement exists for inputing alphabetics, a special purpose keyboard composed of numerics and a limited number of special purpose backlit keys is preferred.

3.1.3 Touch Panel. Used in conjunction with a CRT (which provides feedback), this input device provides touch sensitive areas which are activated when a finger or other object interrupts one of several light paths. The application of this device is limited by low resolution, and it may be difficult to use if the IOS is based on a motion platform; also, the operator must be within arm's length to actuate the device.

Two advantages of touch panels are that the touch sensitive areas are programmable, making it possible for one touch area to take on several functions, and there are no moving parts as in the case of switches or buttons.

3.1.4 Light Pen. This input device is best suited for tasks which require specifying a point on a CRT display, such as selecting an item from a menu. It is hand-held and connected to the computer or display controller interface

by a flexible cable. When not in use, it is held by a clamp near the side or front of the CRT. A switch on the light pen opens a shutter allowing the light from the CRT to generate a signal which is then sent to the computer.

Its limitations are that it is useful only in proximity of the CRT and would be difficult to use on a motion-based IOS.

3.1.5 Voice Input/Output. The voice input/output devices are the essential components of the overall aircraft simulation through which the instructor/operator fills the role of external voice sources and receivers (e.g., control tower, another aircraft crew). These same channels are used for nonsimulation exchanges (e.g., crew briefing).

Voice messages are transmitted and received over a headset connected through a jack at the IOS or a microphone/loudspeaker combination. In both cases, all crew transmissions are always available at the headset, earphones or loudspeaker, but activation of a foot switch, knee bar or HOT MIC selection is required for instructor/operator messages to be transmitted to the crew. Access to these devices is limited, especially for the microphone/loudspeaker combination.

3.1.6 Tactile Displays. These devices provide tactile prompting (e.g., a switch that puts pressure on a resting finger when action is demanded). These devices have limited applications at an IOS since the relevant parts of the body must be in contact with the device at the appropriate instant to be effective.

3.1.7 Foot Pedal and Kneebar. The foot pedal is a foot-operated switch normally used as a press-to-talk switch for the instructor/operator. The foot pedal is connected to the IOS by a certain length of cable and to use the device, the instructor/operator must be within reach of the pedal.

A kneebar is a knee-activated switch under the console and is normally used for the same purpose as the foot pedal; however, it is intended for use by a seated instructor/operator.

3.1.8 CRT Display Cursor Control Devices. This category includes devices such as track balls and joysticks in conjunction with a CRT. One defines a position on the CRT screen by moving a displayed cursor to the desired position. In the absence of an input command the cursor maintains its last position.

Track ball operation involves rotating the exposed portion of a sphere in the desired direction, with the cursor following. A button mounted on the trackball unit is used to initiate an action. Joystick operation produces the same result by swivelling a secured short stick and also operating a button to initiate an action.

There are many other devices or means of positioning a cursor on the CRT; however, these two are the most popular. The use of two controls, one for X and one for Y cursor position, should be avoided since the positions are difficult to coordinate.

3.1.9 Dedicated Push Buttons. One of the most popular man-machine interface devices is the dedicated function push button. It is used primarily for controlling on/off type functions where alternate selections of the push button switch the function between its two states. One of the best configurations is a push button which uses two colors to indicate its alternate states. In this way, a burned out lamp can be found quickly (switch unlit) as opposed to a configuration where the unlit condition is actually one of the valid push button states.

Within the IOS push buttons may be isolated or grouped in clusters. Caution must be taken to avoid large groups of buttons.

3.1.10 Speech Recognition/Synthesis. Devices to automatically generate or recognize speech are an example of new techniques which are being incorporated into flight simulator instructor/operator stations today. Speech recognition systems allow a computer to react to human voice commands. Speech synthesizers are devices driven by a computer to generate near-human words or phrases.

In both directions (recognition/synthesis), the machine vocabulary is limited and exact. The disadvantage of incorporating such systems is that in most systems, when talking to the machine, deliberate silent periods must be inserted between words and the recognition system must be programmed to recognize a specific person's voice.

3.1.11 Summary. This section introduces some of the common and new interface techniques which have been, or could be, implemented at an IOS. Where possible, the applicability, suitability and advantages of the devices have been discussed.

Three of these interface techniques (dedicated push buttons, light pen, and keyboard) were chosen as candidate interface techniques and the impact of implementing them on an IOS is examined fully in Section 4.

## 3.2 Analytical Approach

3.2.1 Time as Principal Criterion. The activities taking place at the IOS are exchanges of information between complex subsystems (i.e., human, machine and task) across an interface. This concept presumes the interface to be continuous, that all necessary and pertinent information is available to the operator in the appropriate format at any time in the training session. In return, the operator must decide on the nature and timing of inputs to be made to achieve instructional objectives by appropriate machine activity, and to deliver the necessary commands to the machine subsystem by means of suitable control devices. However, each of the interface devices treated in Section 3.1 is capable of effectively enabling the achievement of these goals. The logical, task-oriented placement of several of these devices is more effective than employing these interface techniques in a complex conglomeration on an IOS. An IOS extremely well suited for basic flight training may be totally unfit (although all necessary instrumentation is present) for advanced tactics training. The reason for this suitability or lack of suit-

3.2.1 Time as Principal Criterion (Cont'd)

ability is the workload stress imposed upon the operator.

Simply stated, workload stress is the time pressure imposed on an operator by a discrepancy between the amount of work to be done and the time remaining in which to do it.[1] This time pressure depends on parameters such as the task complexity and the importance of the task. Stress affects operator performance. Thus, an operator may be able to conduct easily a flight training mission on an IOS, but in conducting an advanced tactics training mission on the same IOS the operator may be confronted with an arrangement of interface devices which needs more time to operate than the operator can give.

An axiom developed for the analysis of spacecraft crew workloads has been adapted to suit the present purposes:

> A qualified person, that is a properly trained and prepared simulator instructor or operator, can, and will achieve, error-free performance in any IOS task, using almost any interface equipment, provided he/she has unlimited time. In all other cases, his/her performance and the probability of achieving the objectives defined by the training requirements will be a function of his/her total (physical and mental) workload arising from the instructional, operative, and monitoring tasks assigned to him/her and from the physical and temporal relationships applicable during the performance of these tasks.

Thus, time and the effects of excess time or insufficient time were the principal criteria in this development of the evaluation methodology.

Whether or not optimal or even essential compatibility exists at the IOS is by no means obvious from its physical appearance or even from a cursory ergonomic analysis. The designer/evaluator needs a tool to systematically assess the suitability of IOS equipment and functional features for each typical task that may be assigned to the instructor, and to test this suitability in the context of the activities of a representative task profile. The tool is the evaluative model which, through the use of SAINT, analyzes mission performance in terms of time, and the factors which time affects (e.g., stress, boredom).

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[1] Pritsker, A., et al. SAINT: Systems Analysis of Integrated Network of Tasks. Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, 1974.

This approach permits the analysis and comparison of all functional aspects and design details of the IOS as generators or consumers of time, or more precisely, uncommitted operator workload capacity. The "cost" of insufficient information or inadequate machine support appears as excessive time required to complete a given task since the operator has to perform additional work to establish the necessary conditions and satisfactory system performance.

3.2.2 Man-Machine Interfacing Consideration. The considerations of man-machine compatibility and performance are almost endless. Most IOS activities, however, may be grouped accurately into the following five categories:

(a) Perception: becoming aware of new information

(b) Recognition: evaluating, understanding or decoding information

(c) Decision making: intellectual activity leading to a change in behavior

(d) Action: physical activity leading to a command input to the machine

(e) Monitoring: a combination of perception and recognition to ascertain that the desired activity is being obtained.

The effects the interface devices, or the layout of the interface within an IOS, have on the operator is of great importance in evaluating the design of an IOS. For example, if a device intended to attract operator attention is situated in a field of other similar devices, there is a strong possibility that this attention-getter will go unperceived by the instructor. In another case, information may be presented to the instructor in a format which may not be recognizable or useful. The former is an example of a poorly designed layout while the latter is a poor choice of interfacing device; both affect the performance of a mission. It will be shown later that the modular network structure of the evaluative model provides for the representation of these categories either individually or as a lumped set of time-cast parameters within a more extensive activity.

The following paragraphs provide a detailed discussion of these five categories of IOS activity and of how they are affected by the choice of interface devices and the layout of the IOS.

3.2.2.1 Perception. Human performance in this function depends largely on the attention-getting characteristics of a display carrying new information. These may be related to basic readout size and intensity, dynamic behavior, and reinforcement by a secondary signal.

Displays implemented on an IOS may be described in terms of the ease with which the displays are noticed. The stimulus impact of the display may be marginal (nondescript signal in a noisy background), normal or excessive (display overkill). The stimulus impact of a device intended to attract instructor attention can be quantified for use in a TAM, since TAMs contain

some tasks known as "ATTENTION-GETTERS." In accordance with the SAINT method of modelling, a parameter set quantifying the length of time necessary to complete a task must be supplied by the user. The user first determines which of the above three stimulus impacts best describes the device in question, and second, chooses the appropriate parameter set from the parameter index supplied in Appendix G. Probabilities of the instructor successfully noticing the new display must then be assigned by the user. If the display is weak, a low probability is assigned, whereas a high probability of success is assigned to a strong display.

Missing a change in displays due to inadequate presentation results in loss of time and possible mission failures. If a change in a display is not noticed, the operator may proceed to another task totally omitting what might be an essential task in the mission. The display characteristics presented herein apply not only to tasks which call for instructor attention, but also to the simple act of reading any display (e.g., labels on push buttons, positions of switches, or the data presented on CRTs). If a display is poor, i.e., the intensity of a CRT is low, or the label describing a switch is too small to be read easily, the instructor must take additional time to read it. This decreases the time remaining for the mission and, in turn, increases the workload stress felt by the operator, thereby degrading instructor performance.

These display characteristics are accounted for in the TAMs. Every task which requires the instructor to read a message is preceded by a task which describes the display characteristics of the device being read. This task is called an information presentation task (IPTASK).

This method of describing display characteristics, IPTASK, fits well into the TAM scheme, and into SAINT. Ergonomic literature surveys can supply the data to quantify these IPTASKs, and thus, the parameter sets can be developed and inserted into the TAMs to describe the effect of information presentation on instructor performance.

3.2.2.2 Recognition. Following perception, the newly displayed information must be evaluated and understood in terms of the status and progress of the training mission, and in terms of the next step or input required of the instructor. The suitability of the IOS display device is established in relation to the combinations of two types of information being read (qualitative and quantitative) and two purposes for reading (information only, and decision making).

The type of information being read defines basic task difficulty, and the purpose of reading affects the work stress level because more precision is required when data are read for decision making, than in the case of recording data. A single read task is used to describe all possible combinations of information type and purpose. Appropriate quantifying data are added as parameters. In this way the read task, with appropriate parameters, can describe any of the following:

3.2.2.2 Recognition (Cont'd)

(a) Read/interpret moderately complex display by check-reading salient points. Presentation in conventional format. (Read mapping display or graph plot for information only)

(b) Read complex and variable display by check-reading selected values and locations. Presentation in conventional format. (Scan repeater flight instruments for monitoring purposes)

(c) Read/interpret highly complex and variable displays by pattern recognition process. Presentation in comprehensive form. (Read tactical situation display for monitoring purposes)

(d) Read/interpret complex and variable quantitative display by check-reading specific locations and determining changes. Presentation in comprehensive form. (Read heads-up display presentation for decision making)

(e) Read quantitative information composed of partial messages. Presentation of alphanumeric data in the scrolling mode. (Read portable control unit for decision making)

The principal intent of any effort involving recognition is to follow the progress of the training activity and decide on the next activity. From the viewpoint of instructor workload, all changes in displayed information are pertinent although some changes result in a decision that no action is needed. Hence, the principal measure of success in interface design is how quickly the instructor can relate given information to training objectives, and to the input activity required to effect the next step. The model assesses this success in terms of whether or not the instructor has had sufficient time to perform all tasks in such a manner that the continuity, credibility and effectiveness of the training session are maintained.

Recognition performance will normally be satisfactory if the following criteria are met:

(f) All pertinent information is present at the correct time.

(g) Presentation format is easily associated with the conditions of the simulated training maneuver and the instructor task on hand.

(h) Rate of information display and dynamics are within limits of human sensory and cognitive capabilities and form an acceptable workload.

(i) Display format is conducive to quick and unerring operation of the input devices assigned to control the variable(s) in question.

The last of the four is not a factor of recognition as such. It is mentioned here as an important component of the product of this activity (i.e., decision making and input action).

Any significant shortcomings in these areas will force the instructor to perform additional activity, thereby increasing his workload and the possibility of error.

The combination of perception (IPTASK) and reading types provides a means of evaluation display characteristics. SAINT provides the means to determine, in quantitative terms, the effect(s) any of these factors or their combinations have upon the instructor and, thus, their overall contribution to the effectiveness of a given IOS.

3.2.2.3 Decision Making. Decision making is an extremely complex human operator process. A full treatment of decision parameters would by far exceed the capabilities of the model and scope of this study. However, since flight instructors represent a select and highly trained group with above average qualities and skills in control and management of dynamic systems, the assumption has been made that the instructors will invariably make the correct decision if:

(a) They are made aware of new information and pacing factors as discussed in paragraph 3.2.2.1

(b) All pertinent information is made available to them without any further effort on their part as discussed in paragraph 3.2.2.2

(c) The display eliciting their decision has spatial and temporal correspondence with the input device to be used as discussed in paragraph 3.2.2.4.

In this context, decision making includes the determination of the required response and the selection of the input modalities to be used.

The analytical model represents decision making effort by the operator workload and accounts for the cost of decision making in terms of the recognition effort required to make a simple comparison and yes or no decision. The decision itself is almost instantaneous. The time is consumed in the three conditions listed as 3.2.2.3 (a), (b) and (c). Times consumed are products of the interface devices and the IOS layout.

Instructional activities, such as the assessment and documentation of crew performance, also include decision making tasks. Here again, the time costs are accounted for in the acquisition of information and the resulting physical activity.

The RTP requires a debriefing and critique to the trainee immediately following a maneuver. This, in turn, demands that the IOS displays enable the instructor to follow the maneuver and support on-line decisions. Acquisition of the display may involve some activities in addition to the mission operation and monitoring workload.

It may be appropriate to note here that the SAINT operators respond to conditions generating workload stress, but return to their normal performance capability without hysteresis or residual effects as soon as the workload peak passes. The characteristic may be somewhat optimistic considering the average human operator, but seems reasonable for the select group of flight instructors.

3.2.2.4 Actions. The factors considered in the actions an instructor performs on an IOS are as follows:

(a) Basic physical and ergonomic aspects involving visual and manual access to the input device, the suitability of the input method to the task and the resulting workload

(b) Criticality of the input and the possible effects of an error of omission or commission

(c) Operative workload generated by the display/control relationships, e.g., time lag inherent in machine response

(d) Operative workload generated by task conflict, e.g., when instructor has to participate in the simulation with radio messages.

As in the case of displays, it was assumed the fundamental ergonomic requirements and the principles of good human engineering have been satisfied in the general layout and operability of the input devices. The modelling emphasis is on the functional suitability of each device to all tasks assigned to it and on the operative workload in the context of a multitask representative task profile.

Visual access is considered necessary for every manual and reading task, and is included as a parameter in the TAMs. Visual access requires minimal time if only the eyes and head must shift, and slightly more time if the torso must move. However, the cumulative time consumed in a number of visual access tasks is not negligible and could represent a flaw in IOS designs (where a "tennis game" condition exists). Each TAM provides visual access tasks which precede any read tasks. By choosing the appropriate parameter sets, the user can tailor this visual access task to represent either the eye motion only, eye and head motion, or eye, head, and body motion required to view a display.

Manual access has been the subject of extensive research in industrial, vehicular and man-computer applications. Two principal conclusions may be drawn regarding the IOS activities:

(e) Hand movements within the principal operating area will require a constant time expenditure since the arm and hand will accelerate/decelerate according to the transfer distance.

(f) The end task following the hand transfer influences the access time since the operator will approach a device with caution and at a slower speed if the end task is critical or complex or involves unusual hand attitudes.

Manual access tasks precede any task which calls for the activation of a device within a TAM. These tasks may be tailored to fit the appropriate IOS by the insertion of the parameter set which best describes the distance which must be travelled in order to access a device.

3.2.2.4.1 Monitoring. Recognition and decision making are facilitated if the displays and controls are related to each other in a logical way. Manual input is invariably followed by instructor effort and time to verify that the correct system response is being obtained, that the machine is presenting the training problem as planned. A direct and dynamic machine response increases confidence and reduces the overall task time. Consider the example of an illuminated push button which invokes action by changing status before the input and indicates acceptance of the input by a further change in status. The push button illumination may be pulsed when ready for actuation and fully lit once actuated. Further, in the case of a remote echo (cueback or verification display), the TAMs include a verification step containing eye transfer and a reading task in accounting the time costs.

The workload generated by extensive manual tasks (e.g., lengthy typing exercises involved in data entry) is shown by SAINT as increased stress on the operators (in this case, the manual operator, see paragraph 3.2.3.1.2). The model indicates whether this task loading is enough to justify the introduction of a different input mode or automation of some functions.

### 3.2.3 Analytical Network

#### 3.2.3.1 SAINT Provisions

3.2.3.1.1 General. SAINT is a combined network modelling and simulation technique. SAINT was designed to model, in network form, sets of tasks performed during the course of a mission. SAINT obtains mission performance measures for networks which represent a mission consisting of a set of tasks performed by a crew of operators. A simulation approach is used to obtain the performance measures. Human engineering considerations are included through parameters associated with tasks (i.e., time required to perform the task), precedence relations between tasks and factors affecting crew performance (i.e., operator speed, accuracy and stress threshold). SAINT's analysis is performed by a digital computer program which performs two types of analyses. The first analysis (benchmark iterations) obtains estimates of the times required by the operators to perform this mission. The second analysis uses the results of benchmark analysis to obtain mission performance measures which provide estimates of successfully completing the mission under stress conditions (for a detailed description of SAINT, see paragraph 2.2.3).

3.2.3.1.2 Specific Conventions. Several conventions were adhered to throughout this study to adapt SAINT to the evaluative purpose.

The first convention is the division of one human operator (instructor) into seven specialized SAINT operators.

3.2.3.1.2 <u>Specific Conventions (Cont'd)</u>

This convention is necessary because, for this application of SAINT, we need a method of separately allocating various sensory and response modalities of an operator to various tasks. Modelled as one operator, the instructor would be able to perform only one task at any given time due to SAINT's structure. Thus, something as simple as speaking into a microphone at the same time as depressing a foot pedal would be impossible. Therefore, the single instructor has been divided into the following:

(a) Visual operator (#1)

(b) Right manual operator (#2)

(c) Left manual operator (#3)

(d) Cognitive operator (#4)

(e) Audio operator (#5)

(f) Verbal operator (#6)

(g) Pedal operator (#7).

With this configuration it becomes possible for the instructor to look for a switch (visual operator) while depressing a foot pedal (pedal operator). Several tasks may then run in parallel, and the activities of each modality can be tracked.

The second convention is necessary to clarify the availability of the cognitive operator. Since the instructor must be cognizant of every task he/she is doing, and all surrounding events, this would seem to preclude parallel tasks because the cognitive operator cannot be in two places at once. This conflict appears only in the RTP (the TAMs are a straightforward series of tasks) where many tasks are run in parallel and the cognitive operator must be present for all of them. The solution to this problem was found by assigning the cognitive operator to a distinct cognitive task which runs in parallel with the other tasks of the network. The cognitive task is an invented task used to model the instructor's mental processes employed in performance of other tasks. The effects of the instructor having to perform tasks in parallel are shown in the stress levels, and because of the division of the human instructor into seven emulated operators, the facilities of the instructor under greater stress can be identified. Now, the instructor may monitor communications (audio operator) and make written notes (manual operator) at the same time, because the cognitive operator is performing the cognitive task in parallel with the other two tasks and is assumed to be present and aiding in the completion of those tasks.

These conventions, while developed to conform to SAINT's requirements, proved to be an aid in evaluating IOS designs. The division of a human instructor into seven emulated operators allows the user to see exactly what is causing the stress on the instructor (i.e., the visual operator may be overworked while the audio operator is idle).

3.2.3.2 Parameters: Real World to Model. Real world concepts must be quantified in order to make them usable in the model. These concepts must be transformed into mathematical terms (e.g., a mean time, a minimum and maximum time, and a standard deviation) to describe the time taken to perform an activity or the time taken by a characteristic or a device employed on the IOS. In other words, the real world terms must be transformed into basic ergonomic data quantifying the tasks in the TAMs before they can be used in the model.

The categories of tasks where parameters must be quantified are described in paragraphs 3.2.3.2.1 to 3.2.3.2.5.

3.2.3.2.1 Visual Access. Visual access is quantified in terms of the amount of time consumed in moving the eyes, head, torso or any combination of these in order to focus on the device to be read. Ergonomic data classify these times by the distances which must be covered. These parameters describe, in modelling terms, the real world concept of looking from one place to another.

3.2.3.2.2 Manual Access. Manual access tasks are classified in much the same manner as visual accesses. The time needed for a parameter set is that time taken to move either the hand, arm, torso, or any combination of these to a position from which a device may be activated. The actual activation time of the device is not included in this parameter set. As can be readily seen, IOS design and engineering data are the determining factors in the selection of the appropriate visual and manual access parameter sets.

3.2.3.2.3 Device Activation. Device activation is time necessary to activate the chosen device. These parameter sets are not IOS dependent, due to the fact that the hands are assumed (by completion of the manual access task) to be in position to activate the device.

3.2.3.2.4 Read. Read tasks have been classified into four groups. The groups are defined in terms of purpose. This distinction in purpose is evident by the length of time taken to perform the particular read task. The four groups of read tasks are as follows:

(a) Read qualitiative data for information.

(b) Read quantitative data for information.

(c) Read qualitative data for decision making.

(d) Read quantitative data for decision making.

3.2.3.2.5 Display Characteristics. The most intricate parameters to assign are those describing the display characteristics. These parameters must describe, in terms of time consumed, the effect of the display design on the time needed to read that display.

3.2.3.2.6 Literature Searches. It should be noted here that literature searches for the determination of the values of these parameters were beyond the scope of the study. Where values were easily found in available literature, they were used. Values that were not easily located were roughly esti-

mated through experimentation. Members of CAE staff, totally naive to this study, were asked to perform functions (i.e., depress push buttons, locate switch positions, read lines on CRT pages, etc.) on an in-house IOS. The times taken to perform these tasks were recorded and averaged and used as parameter sets. These values are presented in Appendix G.

3.2.4 Summary. The IOS interface is a means of establishing communication between the instructor and the simulator software using displays and control equipment. The interface may be evaluated by the designer/evaluator with regard to functional aspects, operator workload capacity, task time and potential sources of error. The evaluation method chosen is the SAINT model because the network structure of operator performed tasks is compatible with the features of an IOS to be evaluated.

The quality of an IOS can be defined in terms of the ease with which an operator can perform the fundamental activities: perception, recognition, decision making, action, or monitoring.

Perception is the act of becoming aware of new information. The benefits of perception evaluation are significant. Design parameters such as readout size, dynamic behavior, and impact reinforcement of stimulus, and display qualities may be evaluated and selected with respect to the time consumption for which their characteristics are responsible.

Recognition is the decoding of information. Recognition follows perception. Analysis of the time required for the perception activity will aid in the selection of optional display format.

Decision making is a complex human process preceded by perception and recognition. Decision making includes the determination of the required response and the selection of input mode. The cognitive operator (paragraph 3.2.3.1.2) is the only operator capable of making a decision.

Actions are the physical movements necessary to access a device. The parameters describing actions are quantifications of the time consumed by the manual and visual operator due to the layout of an IOS.

SAINT is the software chosen to support the evaluation. Using SAINT, the performance of individual tasks is emulated. Both the emulated operators and tasks have parameter sets describing their performance in terms of time. SAINT's output is given in terms of stress on the operators, times of task completion and number of mission successes (i.e. missions completed within the allotted time) under variable IOS design conditions.

These real world concepts (i.e., perception, recognition, and decision making) are transformed into simulation data through parameter sets. At the TAM level, access tasks, device activation tasks, read tasks and display characteristics are assigned parameter sets found in ergonomic literature, quantifying the times necessary to perform these tasks under different design conditions.

## 3.3 Objective Evaluation Methodology

3.3.1 Introduction. To fulfill the requirement to design or evaluate an IOS interface, the following procedures were required:

(a) A method by which a user could describe a real or conceptual IOS interface in quantitative terms from real life data including an expansion capacity to accept descriptions of new devices and conditions

(b) Objective assessment of an existing or conceptual interface pertinent to the instructional objectives

(c) A format for presentation of results with a quick turnaround and with good visibility of causative factors and potential means of improving performance.

A fundamental requirement was objectivity in the light of the highly subjective and variable assessments obtained in the past. Guidelines were established for the methodology.

(d) Systematic. To model, in a step by step fashion, the activities of an instructor/operator during a training session and to relate, in a logical manner, the output of the model to the input.

(e) Quantitative. To convert real life descriptions and subjective factors into objective, numerical results.

(f) Sensitive. To produce a reasonable and comparable change in the evaluation results for comparable changes in the IOS design or operating conditions.

(g) Repeatable. To produce similar results for similar changes.

A further requirement was that the results of the evaluation be task-specific, showing the suitability of an interface device or function to an instructor activity. This gave rise to two discrete evaluation phases:

(h) Static evaluation, in which the basic physical applicability and operability of a device or control method are assessed against a task, establishing step by step descriptions and time requirements for completion. This evaluation yields the building blocks for the next phase of the evaluation.

(i) Dynamic evaluation, in which an IOS design, composed of the building blocks yielded from the static evaluation, is tested against a representative task profile with many concurrent and possibly conflicting events.

An essentially related effort was to systematically describe the tasks and activities which could be assigned to the instructor. The principal goal was to guide the user from qualitative descriptions of instructional tasks to definitive specification and detailed analyses of all the activities involved in their execution, in quantitative terms suitable for insertion in the model. This was accomplished in the formulation of four developmental steps:

(j) The Instructional Task List (ITL) describes instructional tasks in generic terms.

(k) The Representative Task Profile (RTP) comprises a set of typical training activities arranged to present tasks and workload levels similar to those of a training session.

(l) The Instructor Task Description (ITD) supports the analysis of the typical tasks in terms of information exchanges at the IOS and thereby reflects the results of the man-machine task allocation scheme applicable to the IOS in question.

(m) The IOS Activities List carries details of the elemental tasks and relates these to the use of a given IOS device or function. It also references TAMs which relate the activities required to perform a task to the device used.

3.3.1.1 <u>Instructor Task Descriptions</u>. An analysis of the items of the ITD (a sample is provided in Figure 3-1) revealed that a set of 19 descriptions will cover all the tasks in the RTP. These tasks are:

(a) Monitor crew activities

(b) Display management

(c) Reset malfunction

(d) Arrays display

(e) Simulate surface facilities and communications

(f) Brief crew and demonstrate maneuver

(g) Assess crew cooperation in combat maneuvers

(h) Assess accuracy of verbal communications

(i) Automatic insertion of discrete malfunction

(j) Critique crew performance

(k) Activate discrete malfunction

(l) Simulate ground support activities and communications

| INSTRUCTOR TASK DESCRIPTION | | A | D | IOS ACTIVITIES |
|---|---|---|---|---|
| BRIEF CREW AND DEMONSTRATE MANEUVER | 77 | | | |
| Interrupt simulated flight and training problem | ·78 | | | Apply TOTAL FREEZE |
| Obtain briefing information and ID code for demonstration | 79 | ✓ | | Read Lesson Plan and Notes |
| Activate Recall/Replay function for demonstration | 80 | | | Activate REPLAY Mode |
| | 81 | | | Initialize system to desired starting point |
| Deliver briefing to crew | 82 | ✓ | | Use intercomm |
| Perform demonstration | 83 | | | Activate pre-recorded sequence in replay mode |
| Terminate demonstration | 84 | | | Reset REPLAY mode |
| Re-initiate simulated flight | 85 | ✓ | | Re-initialize system to flight mode and problem status for next training activity |
| | 86 | | | Reset TOTAL FREEZE |
| | 88 | | | |

Figure 3-1 Typical Page from the ITD List

(m) Simulate target conditions and combat activities

(n) Assess accuracy of navigation and ground track control

(o) Assess crew performance in combat maneuvers

(p) Assess accuracy of discrete activities

(q) Document assessment of crew performance

(r) Assess sequence of discrete activities

(s) Assess crew performance in continuous control activities, vehicle handling and flight path control.

3.3.1.2 Typical Activity Modules. The TAM library provides the necessary modelling details to represent almost any given IOS activity listed in the ITD. Furthermore, the tasks within the TAMs may be made active or dormant, an approach which permits flexibility and generalization in definition.

This modular, or building block, approach enabled us to develop an analytical model which the user can easily manipulate to conform to an existing or conceptual IOS without expertise in software or computer methods.

3.3.2 Instructional Task Delineation

3.3.2.1 Instructional Task List (ITL). The first necessary step was to list all known activities required to:

(a) Set up the simulator and define the simulated conditions for the training session.

(b) Control and actively participate in the presentation of the training problem.

(c) Observe and assess trainee progress and proficiency levels.

(d) Document the training session.

In most cases all of the above involve inputs and activities at the IOS, and all necessary displays and controls must be available. However, there is a significant difference between the preparatory phases and the dynamic on-line periods of the session, particularly in terms of the pacing of events and the resulting operator stress.

The Instructional Task List (ITL) (provided as Appendix A) describes the activities of preparing and conducting a training flight, such as setting up ambient weather conditions, some of which are peculiar to simulator training. The description of activities was developed on the basis of the lesson plans of over 100 simulators of various types and represent collective experience with a variety of instructor facilities. Reference to the IOS interface method or the device that may be used to perform a task is intentionally avoided to achieve flexibility and to encourage assessment of hardware.

The ITL provides the designer/evaluator with a checkist by which the overall training objectives may be resolved into their component steps and activities in a systematic manner. Figure 3-2 shows a sample ITL page along with the explanatory legend.

3.3.2.2 Representative Task Profile (RTP). Since, in this evaluation methodology, the criterion for success of an IOS design is whether or not it enables the instructor to perform all essential tasks within available time, and since the instructor workload is the key to effective measuring of an interface device, it was necessary to construct a typical task profile against which the candidate IOS interface methods could be evaluated or compared in a quantitative fashion.

A typical training mission has been assembled with a reasonable sequence of events selected from all sections of the ITL. The operative display/control tasks have been arranged to resemble the phases of the training flight. Continuous didactic tasks, such as monitoring of the trainee and performance assessment, have been added to the appropriate mission phases. A pattern of malfunctions was activated both in the manual and in the preprogrammed mode. The simulated flight was interrupted at certain points to deliver briefings, critique and demonstrations where this could be done without destroying the continuity and credibility of the presentation.

The RTP (Appendix B) represents both high and low instructor workload periods, but in its basic form it is still independent of the IOS interface methodology. It describes the tasks and events in real world language. However, descriptions are so structured that they may be directly related to typical activities and tasks defined later which, in turn, can be selected to reflect the IOS functions and features to be used.

The representative task profile has served multiple purposes.

(a) As an initial task sequence to model activities on a hypothetical IOS and to validate that model.

(b) As a standard sequence or benchmark task against which candidate IOS methodology and equipment could be prepared.

(c) To support the development of a method whereby real world and engineering descriptions could be transformed into modelling terms and parameters in a systematic fashion.

Performing the task sequence represented by the RTP presents the instructor with workload peaks, task conflicts, interim periods and an overall task duration similar to those of a typical training session in terms of frequency and intensity of workload fluctuations.

INSTRUCTIONAL TASK LIST

| TASK NO. | DESCRIPTION | PACING SOURCE | | | | | | | NATURE | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | LP | IN | TP | TS | SN | NS | MT | P | D | R | E |
| 3.8 | - Malfunctions | | | | | | | | | | | |
| 3.8.1 | - Designate preselect malfunction | X | X | X | X | | | | | X | | |
| 3.8.2 | - Specify criteria for preselect malfunction | | X | X | X | | | | | X | | |
| 3.8.3 | - Arm malfunction | X | X | | | | | | | X | | |
| 3.8.4 | - Insert discrete malfunction | | X | X | X | | | | | X | | |
| 3.8.5 | - Insert variable malfunction | | X | X | X | | | | X | | | |
| 3.8.6 | - Reset all malfunctions | | X | | | | | | | X | | |
| 3.8.7 | - Cancel discrete malfunction | | | | | | | | | | | |
| 3.8.8 | - Cancel variable malfunction | | | | | | | | | | | |
| 3.9 | - Radio Facilities | | | | | | | | | | | |
| 3.9.1 | - Fail Radio Facility | | | | | | | | | | | |
| 3.9.2 | - Reset all failed radio facilities | | X | | | | | | | X | | |
| 3.9.3 | - Verify tuned Radio facility | | | | | | | | | | | |
| 3.9.4 | - Set up portable radio facility | | | | | | | | | | | |

LEGEND:

Pacing Sources

LP Lesson Plan

IN Instructor Decision

TP Trainee Performance

TS Trainee Proficiency Level (Long term training status)

SN Simulation or Model - related

NS Not directly related to simulation or model

MT Maintenance - related

Nature

P Perception of Stimulus and/or processing of information

D Decision making

R Reaction (manual input)

E Environmental

Figure 3-2 Sample ITL Page

In its specific form, where references to IOS functions and devices have been added, the RTP closely approximates a one-hour training session planned for a military simulator of a jet aircraft. The IOS of this simulator is heavily supported by software and CRT displays, with direct action controls provided for functions such as mapping, plotting, recording functions, preprogrammed problem presentation, and communications channels where timing is essential or where instructor convenience is improved. In its present form, the RTP is heavily biased toward step-by-step manual operation, although many automatic functions are available. Automatic functions could be used to alleviate workload through a redistribution of tasks or a retrofit of the IOS design.

Figure 3-3 shows a sample page of the RTP. This page represents the instructor tasks during leg 7 (roll-in and shutdown of the aircraft) of the total mission. The ITL column on the page shows the location of these tasks in the ITL. This example will be elaborated upon in each of the following two sections and provide a clear picture of how the RTP was used.

3.3.2.3 Instructor Task Description. Selected items from the ITL have been assembled to form an RTP. The items of the RTP, such as, ASSESS SEQUENCE OF DISCRETE ACTIVITIES, were further broken down in the ITD into their component tasks (e.g., obtain information by observing crew activity, verify against standard procedure, note results of assessment) in order to reach a level of detail where repetitious statements could be used as elements in the description of a task or event. The right-hand side of an ITD page (Figures 3-4 to 3-8) provide a menu of the various ways an instructor can perform tasks on an IOS. Not every item in the menu applies to every IOS design. The user need only check the menu items which pertain to the IOS being evaluated.

The RTP was composed of repetitions of 19 tasks. These tasks have been expanded into the ITD and are now considered modules. This modularization greatly aided the development of the SAINT-RTP network (paragraph 3.3.6.2). Each task in the ITD module menu has been assigned a permanent task number which corresponds to that task in the main SAINT network. The task applicable to the IOS under study is checked A (active, as opposed to D, dormant) by the evaluator, thus making the module IOS specific. This form serves as a record of the activities included in the module.

Figures 3-4 to 3-8 show the expansion of Figure 3-3 into an ITD. The checkmarks indicate which menu items have been activated to emulate how the ITD heading would be performed on a jet trainer IOS.

3.3.2.4 IOS Activities List. Finally, the descriptive chain has been completed with a listing which links the instructive tasks of the RTP and the man-machine task allocation of the ITD to the available/desirable IOS devices and functions. The IOS Activities List (Appendix E) contains a description of the interface devices, a brief description of how the device operates, and references the TAM (which contains the model of the operator use of the device). Figure 3-9 is a sample of the list. This is the last link of the descriptive chain. The user need only match the tasks from the ITD menu with the device on the IOS (described in the Activities List) and select the TAM indicated. Then the user inserts the proper parameters into the TAM and runs

IOSS REPRESENTATIVE TASK PROFILE

| | | ITL | LVDU | RVDU |
|---|---|---|---|---|
| 7.0 | ROLL-IN & SHUTDOWN | | | |
| 7.1 | Shutdown Checklist Procedures | | P 50 | |
| 7.1.1 | Call Up Crew Activity Monitor Display | | P 50 | |
| 7.1.2 | Assess Sequence of Discrete Crew Activity | 4.2.1 | | |
| | Monitor Shutdown Procedure Checklist Activity | | P 50 | |
| 7.1.3 | Assess Crew Cooperation | 4.2.4 | | |
| | Monitor Intercomm Exchanges | | | |
| | Monitor CAM Display on line | | | |
| 7.2 | Post-landing Debrief | | | |
| 7.2.1 | Apply TOTAL FREEZE | 3.7.1 | | |
| 7.2.2 | Debrief Crew | 5.1.5 | | |
| | Use CAM Records | | P 50 | |
| | Use MAP | | | MAP |
| | Use written notes | | | |

Figure 3-3 Sample RTP Page

| INSTRUCTOR TASK DESCRIPTION | A | D | IOS ACTIVITIES |
|---|---|---|---|
| MONITOR CREW ACTIVITIES | | | |
| Arrange Displays | ✓ | | Call Up Crew Activity Monitor Display Page |
| Activate Crew Action Monitoring System | ✓ | | Activate CAM in the Manual Mode |

Figure 3-4 ITD

| INSTRUCTOR TASK DESCRIPTION | | A | D | IOS ACTIVITIES |
|---|---|---|---|---|
| ASSESS SEQUENCE OF DISCRETE ACTIVITIES | | | | |
| | 42 | | | |
| Obtain information by observing crew activity<br>Re: System Checklist Responses | 43 | ✓ | | Read Crew Activity Monitor display |
| | 44 | ✓ | | Monitor intercomm exchanges |
| Verify against standard procedure | 46 | ✓ | | Read standard procedure checklist |
| Note results of assessment | 45 | ✓ | | Make written notes |
| | 47 | | | Cognitive |
| | 48 | | | |

Figure 3-5 ITD

| INSTRUCTOR TASK DESCRIPTION | | A | D | IOS ACTIVITIES |
|---|---|---|---|---|
| ASSESS CREW COOPERATION | | | | |
| | 49 | | | |
| Observe crew activities | 50 | ✓ | | Read Crew Activity Monitor Display |
| | 51 | ✓ | | Monitor intercomm exchanges |
| Compare to problem Flight status | 52 | | | Scan synthetic instruments, ADI, BDHI |
| Compare to standard procedure | 54 | ✓ | | Read standard procedure checklist |
| Note results of assessment | 53 | ✓ | | Make written notes |
| | 55 | ✓ | | Cognitive |
| | 56 | | | |

Figure 3-6 ITD

| INSTRUCTOR TASK DESCRIPTION | | A | D | IOS ACTIVITIES |
|---|---|---|---|---|
| CRITIQUE CREW PERFORMANCE | | | | |
| | 67 | | | |
| Interrupt simulated flight and training problem | 68 | / | | Apply TOTAL FREEZE |
| Obtain performance data on problem just completed | 69 | / | | Read CAM display page |
| | 70 | | | Scan Mapping Display |
| | 71 | | | Graphic Plots |
| Compare performance data to desired performance indices | 72 | / | | Read procedure/performance standards |
| Perform critique immediate feedback to trainee crew | 73 | / | | Use Intercomm |
| | 74 | / | | Use notes |
| | 75 | / | | Cognitive |

Figure 3-7 ITD

| INSTRUCTOR TASK DESCRIPTION | No. | A | D | IOS ACTIVITIES |
|---|---|---|---|---|
| DOCUMENT ASSESSMENT OF CREW PERFORMANCE | | | | |
| | 89 | | | |
| Records assessment results | 90 | ✓ | | Make formal written notes |
| Record discrete crew activities | 91 | ✓ | | Hard copy CAM display page |
| Record performance data | 92 | | | Hard copy Appr. Plot |
| Create performance record file | 93 | ✓ | | Perform keyboard task to transfer data to disc files |
| | 94 | | | |

Figure 3-8 ITD

IOS ACTIVITIES LIST "OPERATE" TASKS

| Description of Device | Description of Operation | Classification |
|---|---|---|
| Push Switch, Pushbutton | | |
| Single, unique by location | Manual access needs little visual dwell time<br>Simple end task, no decisions<br>No local feedback | TAM 20 |
| One in bank or row not unique | Manual access needs some visual dwell time<br>Simple end task, no decisions<br>No local feedback | TAM 20 |
| Illuminated, single unique by location | Changes status or color AFTER activation<br>Manual access needs little visual dwell time<br>Simple end task, no decisions<br>Adequate local feedback | TAM 20 |
| Illuminated, one in bank or row, not unique | Changes status or color AFTER activation<br>Manual access not helped by illumination, needs visual dwell time depending on status of others<br>Simple end task, no decisions<br>Adequate local feedback | TAM 20 |

Figure 3-9 Sample IOS Activities List Page

SAINT. An analysis of SAINT's output will give the evaluator data as to the suitability of the device to perform the task.

For example, if the user is evaluating the IOS using leg 7 of the RTP (Figure 3-2) and is trying to make ITD Ref. 7.2.3 (Figure 3-8) IOS specific, the user checks tasks 90, 91, and 93 active. In order to perform task 91 (hard copy CAM display page), the evaluator will have to check the Jet station. This check shows that hard copies are obtained via push button. The user then goes to the Activities List (Figure 3-9) and finds the description of push buttons best describing those on the jet trainer IOS and finds the TAM (20) that contains the model of the actions necessary to perform task 91 on a push button. The user then inserts the appropriate parameters into TAM 20, runs SAINT with that TAM 20 data and obtains the static phase of the evaluation. The insertion of the data gathered from this evaluation into task 91 in the RTP model will yield the data to be analyzed for the dynamic phase of the evaluation.

3.3.3 Evaluation Guidelines and Criteria. Advantages of the live model approach to the evaluation of the design of an IOS may be summed up as follows:

(a) The model establishes repeatable conditions of testing

(b) The model accepts quantitative, objective performance measures

(c) The method uses standardized criteria of performance

(d) The method produces repeatable results and detailed documentation.

The parameters of evaluation can be divided into three classes as follows:

(e) Independent Variables. Independent variables are training objectives and instructor task definitions which may be set for any representative profile. Interface methodology and devices which may be selected independent of other factors are also independent variables. The independent variables were held constant during the development of the modelling network, and the interfacing methodology parameters were varied during the validation tests both in an arbitrary manner and in a controlled mode by redefining the interface devices.

(f) Dependent Variables. The principal dependent variables are time available to perform all tasks and the human operator performance characteristics.

(g) Control Variables. The control variables are the parameter sets of the modelling network and are defined by ergonomic data and/or real world experience. These variables carry the principal means of controlling the model.

As general guidelines, it was established that the basic tasks should be defined individually, and intrusive conditions (e.g., display formats, information types presented) should be modelled as tasks performed by the machine (no operator associated with the task). Thus, these characteristics are treated as any other tasks with timesaving, or time-consuming attributes. All tasks are modified by their parameter sets.

Evaluation criteria have been derived from performance parameters and operating conditions. The principal parameter of evaluation is time, therefore, the principal criterion of evaluation is the time to complete all tasks.

Another criterion is the availability of information. This relates the IOS devices and functions to the parameters of performance and avoids such ambiguities as the lack of a display device which could be falsely shown as saving in time since it does not need to be read.

Although these two criteria represent the cardinal metrics of evaluation, the model provides these further details:

(h) Criteria of Suitability for Information Exchange

(1) Attention-getter

(2) Display format

(3) Accessibility and frequency of visual relocation.

(i) Criteria of Control Harmony

(1) Layout of devices, frequency of manual access

(2) Input task complexity

(3) Dynamic system response check, e.g., local cueback.

The model, especially the TAMs, provides input ports for other parameters through SAINT's capability to easily manipulate parameters for the evaluator.

3.3.4 Evaluation Methods

3.3.4.1 Static Aspects. Static evaluation covers the basic suitability of an IOS device or function for a given task defined in the ITD. In other words, the static phase of an evaluation analyzes the availability of basic IOS interface devices to effect the necessary man-machine information exchange. The process consists of the following steps:

(a) Correct interpretation of the physical layout from engineering data and the factors possibly affecting the task time.

(b) Systematic assessment of visual and manual access conditions.

(c) Assessment of conditions of information exchange, availability of displays and operability of controls.

It is assumed that the fundamental human factors and ergonomic requirements have been satisfied and therefore accounted for in the data used to establish the task times.

The static phase of the evaluation is carried out at the TAM level. It is at this level that the ability of an interface device, and its placement on the IOS, to have a particular task performed in it is tested. An example will more clearly illustrate the concept of static evaluation. It should be recalled here that TAMs model isolated functions with no regard to a lesson plan or surrounding activities (paragraph 2.2.3.6). If an evaluator wishes to determine the feasibility of calling up a map on the left CRT, scaling the map, and centering the aircraft on the map using the auxiliary keyboard (AKB) situated on the right side of the IOS, the evaluator would choose the KEYBOARD TAM. The evaluator would then read the engineering data to determine distances to be traversed both visually and manually. Armed with these data, the evaluator would choose the appropriate parameter sets (as dictated by the engineering data) from the listing of Parameter Sets (Appendix G) and assign them to each task in the keyboard TAM. The final parameter to be decided on is the time to allot for the performance of this task on the particular interface device. When that is done, these data are processed by SAINT. From SAINT's output, the evaluator can determine whether the AKB is a suitable interface method for calling up, scaling and centering maps by analyzing the number of successful missions, average time of completion, stresses on the operators, etc.

The data obtained in static evaluation are thus valuable in themselves and, as will be seen, are an integral part of the dynamic phase of evaluation.

3.3.4.2 Dynamic Aspects. The individual task device combinations must be tested in the context of the IOS interface as a whole under realistic conditions involving multiple simultaneous tasks and activities. This testing constitutes the dynamic phase of the evaluation. The main analytical model (i.e., model of the RTP) is the tool used for this phase.

Data obtained through the static phase of evaluation (i.e., average time of mission completion and the probability of success) are inserted into the model of the RTP. In conjunction with the example presented in paragraph 3.3.4.1, the average time values of the keyboard TAM will be inserted into the main model each time maps must be called, scaled, and centered. This TAM is no longer isolated, but it now affects and is affected by other TAMs in this representative lesson plan. From this dynamic model, the effects of all aspects of the IOS, in conjunction with TAMs and the application of the IOS to the lesson plan, are set forth in terms of mission success, times of completion and stress levels on the operators. It may be found, for example, that calling maps via AKB causes higher stress on the operators during the RTP mission than using a voice controller or push button. It is this kind of information which aids a designer in developing a new IOS.

3.3.5 Model Construction - Typical Activity Modules. The tasks identified by the task analysis, in this case the RTP, as well as expanded into modellable events whereby each action of the instructor, and every IOS equipment task performed, is accounted for. Repetitive groups of such events can be described by TAMs. A TAM describes a typical instructor/IOS activity in sufficient detail so that most task requirements may be matched to most IOS configuration details by selecting the appropriate TAM, thereby avoiding the work of individual analysis. The advantage of expanding these tasks into the form of TAMs is that relatively few TAMs comprise a library of "building blocks". They may be selected to describe a wide variety of IOS activities without repeating the analytical process.

TAMs describe each action an instructor performs to accomplish a task with a designated interface method. The TAM title identifies the interface device being used. For example, if a decision on whether a toggle switch or a dedicated push button would be more advantageous in a particular IOS, the toggle switch TAM and the push button TAM can be run. The more advantageous device will be thus shown. However, the impact of each device on the implementation of a lesson plan can be shown by replacing the toggle switch TAM with the push button TAM throughout the RTP and analyzing the output. The comparison of output from RTP simulations using each device will show whether the different devices do indeed affect the instructor workload.

A typical TAM and its SAINT-defined flowgraph are shown in Figures 3-10 and 3-11. The TAMs are supplied for the user with a grid in which tasks can be checked as either active or dormant.

Stepping through the TAM, the user can decide if an attention-getter is necessary for the task at hand. Task 10, with its parameter sets, accounts for the time it takes for the visual operator to focus on a display. The IPTASK allows the user to account for the display characteristics by choosing the appropriate parameter set. The type of information displayed and its time consuming effects are accounted for in tasks 50 to 53. The amount of time taken to read the display is accounted for in tasks 60 to 63. Having obtained this information, the SAINT operator must decide whether or not to change the display. If not, task 80 will branch to the end of the network. If so, the visual operator must now focus from the display to the keyboard (task 11). The manual operator must move to the keyboard (task 20) and key in the proper code. As can be seen from the flowgraph, task 30 branches back to task 10. The reason for this repetition of tasks is to allow the instructor to check that the display called up is the correct one before pressing the INSERT button. If the evaluator is sure that the instructor will not perform this check, he/she can specify to SAINT (see User's Guide, Appendix I) that the parameter sets of these repeated tasks be set to zero (i.e., they will not use any time allotted to the mission). The remainder of the TAMs, and their flowgraphs, can be found in Appendix F.

3.3.5.1 TAM Philosophy. The events that can be modelled in the TAMs are divided into two categories: constant and device-specific. Some activities require the same amount of time to perform regardless of the device; hence, it is the number of times they are performed that spells out the difference in the IOS interfacing methodology. The device-specific tasks reflect the mech-

KEYBOARD TAM 18

A . D

| | | |
|---|---|---|
| 1 | Attention Getter | |
| 10 | Visually Access Display | |
| 40 | IPTASK | |
| 50 | Information Type | I |
| 51 | | II |
| 52 | | III |
| 53 | | IV |
| 60 | Read (Type I) Display | |
| 61 | II | |
| 62 | III | |
| 63 | IV | |
| 80 | Decide to Change Display | |
| 11 | Visually Access Keyboard | |
| 20 | Manually Access Keyboard | |
| 30 | Key In (Param. Set Choice) | |
| 10 | Visually Access Display | |
| 40 | IPTASK | |
| 50 | Information Type | I |
| 51 | | II |
| 52 | | III |
| 53 | | IV |
| 70 | Display Delay | |
| 60 | Read (Type I) Display | |
| 61 | II | |
| 62 | III | |
| 63 | IV | |
| 81 | Verify Change has been implemented correctly | |
| 12 | Visually Access Keyboard | |
| 21 | Manually Access Keyboard | |
| 31 | Key INSERT (P.S.) | |

Figure 3-10 Sample TAM

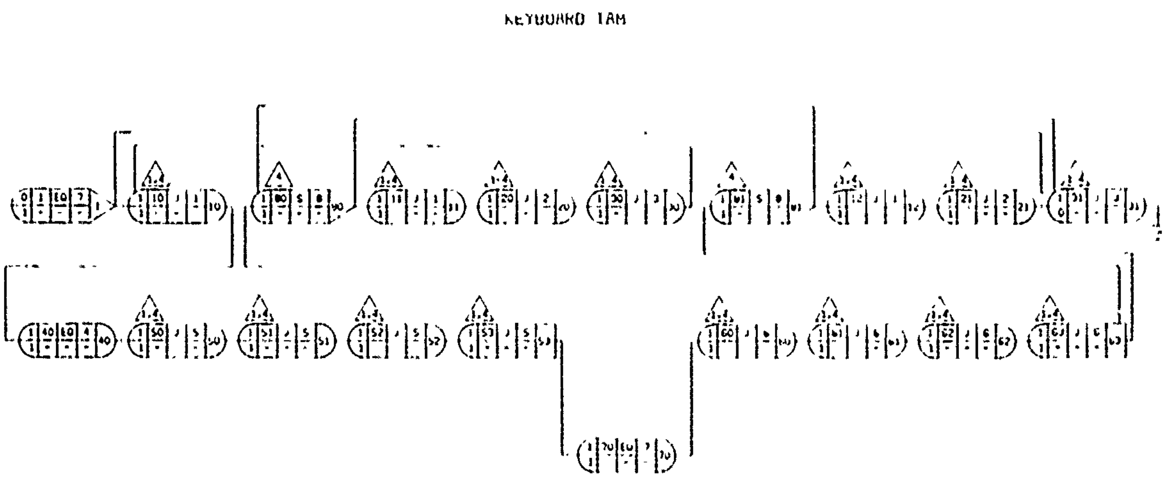



Figure 3-11 Sample TAM Flowgraph

anization of the IOS and the entire interfacing methodology. TAMs have been developed for such devices as the light pen, light gun, push buttons, rotary switches, potentiometers, keyboards, and toggle switches.

TAMs have two basic functions. They are building blocks for the RTP and also independent evaluative tools. In its present configuration, SAINT has the capability of processing 200 tasks (declaring SAINT's arrays to larger dimensions enhances the number of tasks it can process). However, the model of the RTP, using each TAM in its full form, far exceeds 1,000 tasks. Although SAINT can be made to process these tasks, the network would be a mass of confusion. SAINT itself provides a method of circumventing this problem. By utilizing SAINT's mission summary output, it is possible to reduce a TAM to the status of a single task (for use in the RTP), with parameter values which are supplied by the mission summary. The TAM can be inserted into the RTP as a single task which contains time parameters indicative of the entire TAM. In this manner, a complete leg of a representative mission can be established as a single network comprised of condensed TAMs and exercised to evaluate the particular IOS in a representative flight regime.

TAMs may also be used to evaluate devices independently. Using engineering design data to choose the appropriate parameter sets, the desirability of two candidate interface devices for an IOS can be evaluated in terms of time taken to perform a task and the workload stress placed on the operators. This evaluation can be carried a step further: if a leg of the RTP is run and the analysis of the output reveals that stress is high in a certain group of tasks, those condensed TAMs can be identified, expanded, and analyzed and changes implemented. The revised expanded TAM can then be summarized and inserted back into the RTP. Results of the changed tasks in the TAMs will be seen.

3.3.5.2 Structure. TAMs are designed in a generalized form to account for every possible action that may be needed. This structure is made possible by allowing a task to be in one of two modes. dormant or active. Because every event is accounted for in the TAM, not all of these events will be needed in each evaluation. Those extraneous tasks can be assigned a task time requirement of zero and considered dormant. Setting the time parameters equal to zero causes the dormant task to use zero seconds of the time allotted to the mission while remaining in the network. If a task is not needed for the present evaluation, the TAM need not be revised. Rather, the values of the parameter set for the task need only be set to zero, thus maintaining the integrity of the TAM. An active task has a parameter set equal to something other than zero.

TAMs are structured as a series of tasks performed by operators which flow through the networks. The branching from tasks is mostly deterministic, with few probabilistic branches. The probabilistic branching occurs from tasks which involve decision making. Decision making tasks consist of verifications that data presented are correct or the decision to change the present display. One of the branches is the correct branch, i.e., the branch taken if the task is performed correctly. The other branch is the incorrect branch, which leads to either the last task of the mission or back to the procedure which was incorrectly performed.

Attention-getters are considered to be equipment tasks. That is, they are treated as any other tasks. They consume time, they affect the mission (especially if they are not noticed by the instructor), but they are performed by the IOS. Therefore, no emulated operator is assigned to them. These attention getting tasks are modelled as probabilistic tasks. The values assigned to the branches are the probabilities of the instructor noticing the signal. If the instructor misses the cue, the task branches to the end of the TAM, skipping all the interim tasks necessitated by the attention-getter. If the attention-getter is not necessary, the task is assigned a parameter set where values are equal to zero (i.e,, made dormant) and a probability of 0.99 is assigned to the correct branch. The rationale for the assignment of 0.99 instead of 1.0 is due to a limitation of SAINT. If a probabilistic task branch is assigned a value of 1.0, SAINT interprets it as a deterministic task, but all the task decriptors state that the task is probabilistic and a SAINT error occurs.

3.3.5.3 Tasks. Tasks contained in the TAMs can be divided into the following categories:

(a) Visual access

(b) Manual access

(c) Operation

(d) Information type

(e) Read

(f) Decision

(g) Display qualifier

(h) Attention-getters

(i) Display delays.

Access tasks are those which take an operator from his/her present position to the position required to perform the next task. Visual access can be further divided into three subdivisions:

(j) Eye movement only

(k) Eye and head movement

(l) Torso movement.

Each of these subdivisions has a parameter set associated with it. Eye movement occurs only when the visual operator travels a distance less than or equal to 12 inches (30.5 cm). Head and eye movements are usually needed to access a device between 12 and 24 inches (30.5 and 61 cm) away. Distances greater than 24 inches require torso movement. Visual and cognitive operators are assigned to these tasks.

3.3.5.2 Tasks (Cont'd)

Manual access is similar to visual access. The subdivisions are the same, but the parameter sets differ. Manual access does not include the activation of the device, only the movements of the operator to a position from which the device can immediately be activated. Manual, visual and cognitive operators are assigned to these tasks.

The visual and manual access tasks are key factors in the evaluation of an IOS. If an IOS is designed in a manner which requires many repetitive motions to access devices, the operator will show a higher stress level and a mission will require more time than will be the case on a better IOS layout.

Activational tasks are those which cover the actual manipulation of a device, e.g., depressing a push button or rotating a potentiometer. There is a parameter set describing the time requirements for the manipulation of each device. Thus, in an evaluation or in a design, different devices may be inserted into the TAM and the effect of each device on mission time and operator stress can be calculated by SAINT. Manual, visual, and cognitive operators perform these tasks.

Four types of information capable of being displayed have been identified. Information Type I consists of groups of two to four words of 1.5 syllables/word. Information Type I is usually seen in the form of labels on or around activational devices.

Information Type II is opaque and displayed on a CRT or in printed form. It consists of a limited, repeatable vocabulary containing words averaging 2.2 syllables/word. Any page, such as malfunction page, lesson plan, or initial conditions, falls into this category. Visual and cognitive operators are assigned to these tasks.

Instruments, either repeater or synthetic where only gradations and numbers on the instruments are used, comprise Information Type III.

Information Type IV includes pictorial displays, i.e., maps, landing approaches, etc. The parameter sets describing these information types account for only the actual act of reading the information. The reason for reading, or the thoroughness with which they are read, are accounted for in read tasks. Cognitive and visual operators perform these tasks.

Reading tasks used in the TAMs are those described in paragraph 3.2.2.2. The visual and cognitive operators are assigned to these tasks. Decision tasks used in the TAMs are explained in paragraph 3.2.2.3. The cognitive operator performs the decision task.

Display qualities are accounted for in an information presentation task (IPTASK). In keeping with the scheme of the TAM, the IPTASK immediately precedes the information type task, which immediately precedes the read type task. Thus, any device to be read is quantified by its display characteristics. These include:

3.3.5.2 Tasks (Cont'd)

(m) Luminance

(n) Contrast

(o) Flicker

(p) Color

(q) Resolution

(r) Size

(s) Character generation method

(t) Surrounding area.

Time values for each of the parameters are to be determined by the user (either through data searches or by experiment) in developing a parameter set for an IPTASK. A display where applicable characteristics take zero time away from the reading of the device (i.e., a good display) will be assigned a parameter set where mean, minimum, maximum, and standard deviation values are zero. If one of the characteristics is poor (e.g., contrast), additional time will be required to read the display. Therefore, the mean value in the parameter set shall be the average amount of time that characteristic consumes. If all the characteristics considered in the IPTASK sum up to an average display (i.e., the mean of the parameter set equals zero) and then one of those characteristics is improved until it greatly helps the quality of the display, the IPTASK will be assigned a negative mean time in the parameter set. A negative mean time for a task causes the expected end time to be lower than that for its predecessor task. For example, if the end time of the predecessor of the IPTASK is 130.00 seconds into the mission, and the contrast characteristic of a display has been improved until it is better than average, the IPTASK parameter set will be assigned a mean of -1.0. Thus, the expected end time of the IPTASK will be 129.00 seconds, thereby adding an extra 1.0 second to the time allowed for the mission.

Attention-getting is another equipment task. If an attention-getter is needed for the running of the TAM, a parameter set, with a value calculated in a similar way to that of the IPTASK, and reflecting the same characteristics, is assigned to the task. The probabilistic branching from the attention-getter reflects the probability that the attention-getter is noticed.

Another task seen on some TAMs is the display delay. This is the time delay between activation of the device and feedback. Obviously, a high time cost in a display delay causes time to be taken from the remainder of the mission.

3.3.6 Modular Network Construction. Through the development of the ITD and the IOS activities lists, the frequency with which some instructor tasks occurred during the RTP was determined. The IOS Activity List shows the resolution of these instructor tasks into SAINT defined tasks, or subtasks. In the real world, several tasks were performed simultaneously by various operators. Thus, parallel representation of some tasks was necessary.

Figure 3-12 shows the module entitled ASSESS SEQUENCE OF DISCRETE ACTIVITIES. This is the SAINT flowgraph depicting the ITD sequence of actions shown in Figure 3-13. The numbers within the nodes of the flowgraph are not relevant to this discussion, but are explained in the User's Guide, Appendix I. The right-most number in the node corresponds to the task with the same number on the ITD (Figure 3-13). Tasks 42 and 48 have no descriptors in the ITD. This is because they are dummy tasks (i.e., represent nothing and have zero value parameter sets) and are present only for branching purposes. They ensure that all operators are present to perform the tasks of the module, and that all leave the module to go on to the next module. The triangles in the network represent an operator and the number inside the triangle identifies the operator. Tasks shown in parallel (Figure 3-12) are considered to be running simultaneously. Thus, a human instructor divided into emulated operators (visual, manual, audio, cognitive: see paragraph 3.2.3.1.1) can monitor intercom exchanges (task 44, operator 5), make written notes (task 45, operators 2 and 3), read crew action monitor (CAM) and standard procedure checklists (tasks 43 and 46, operator 1) simultaneously. Parallel tasks have a strong effect on the workload stress of the operators. As explained in paragraph 3.2.3.1.2, the mental processes of the instructor, represented by the cognitive operator (operator 4) performing a cognitive task (task 47), continue throughout the duration of the module.

The user annotates each task sheet to indicate whether the subtask is active or dormant. These groups of tasks are then arranged through proper branching to form the model of the RTP. This modular method has several clear-cut advantages from the user's viewpoint. First, the integrity of each module, its flowgraph and its task descriptors, remain intact. The entire set of subtasks comprising the ITD item will always be presented together, although only a few of those subtasks may be required. Second, this modularization of the subtasks allows the user to develop a much smaller network. Instead of repeating each ITD item as it is required (up to four times during some legs of the RTP), the user merely branches back to the required module as often as necessary.

This repeatability has another advantage. Due to the fact that the modules are repeated instead of rewritten (which would entail assigning a new identification number to the same task each time it is rewritten), it becomes possible for the user to determine the sum of the times taken to perform a particular task by locating only one task number. This is opposed to searching the printout for the same task represented by several different numbers. For example, the ITD, ASSESS CREW PERFORMANCE IN CONTINUOUS CONTROL ACTIVITIES, VEHICLE HANDLING AND FLIGHT PATH CONTROL occurs five times. One of the subtasks, or IOS activities of that ITD, is task 59, which is MAKE WRITTEN NOTES. The amount of time spent making written notes during the five times the crew performance was assessed can be tallied simply by summing the times

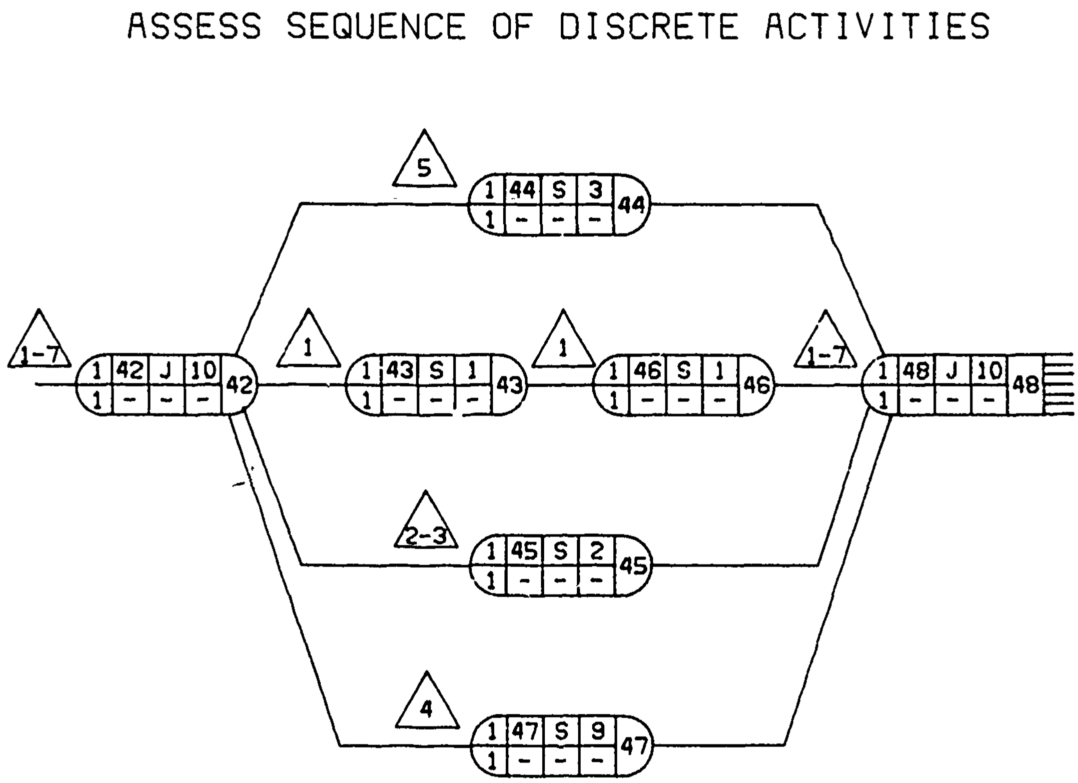



Figure 3-12 TAM Module

| INSTRUCTOR TASK DESCRIPTION | | A | D | IOS ACTIVITIES |
|---|---|---|---|---|
| ASSESS SEQUENCE OF DISCRETE ACTIVITIES | | | | |
| | 42 | | | |
| Obtain information by observing crew activity<br>Re: System Checklist Responses | 43 | ✓ | | Read Crew Activity Monitor display |
| | 44 | ✓ | | Monitor intercomm exchanges |
| Verify against standard procedure | 46 | ✓ | | Read standard procedure checklist |
| Note results of assessment | 45 | ✓ | | Make written notes |
| | 47 | | | Cognitive |

Figure 3-13 Sequence of Actions (ITD)

task 59 is used. Were it not for the modularity of the ITD, the task MAKE WRITTEN NOTES would have appeared five times with five distinct identification numbers, causing the user considerably more difficulty in locating the times for these tasks.

The complete set of module flowgraphs, along with the SAINT data for each module, is presented in Appendix D.

3.3.6.1 General. There are 19 basic ITD items which comprise the instructor tasks of the RTP and are repeated throughout the RTP. The subtasks of these items have been flowcharted to SAINT specifications and remain uncorrupted in any subsequent modelling. Every subtask comprising each ITD item has been assigned an identification number which should not be changed by the user. The branching from task to task in the flowchart of the modules should also be left intact. An explanation of the symbology will follow.

Also associated with the flowchart of each module is the data describing each task comprising the block. It is here that the user controls the model by inserting the desired parameter sets and time perturbations which describe the tasks.

For example, ITD item SIMULATE SURFACE FACILITIES AND COMMUNICATIONS can be used to illustrate the principles followed in flowcharting (see Figure 3-14). Tasks 95 and 102 are dummy tasks, inserted solely for branching purposes. They do not represent any IOS activities. Task 95 collects all seven operators and readies them to release their designated tasks. Task 102 collects all seven operators after they have completed their tasks and sends them to their next designated task via CONDITIONAL, TAKE FIRST BRANCHING. Due to the parameter sets assigned to these tasks, they use zero time from the allotted mission time. The task numbers correspond to task titles set forth in the ITD (Figure 3-15). All operators gather at task 95 and then branch through the module. Upon completion of task 88, CHECK LESSON PLAN, the audio operator proceeds to task 90, MONITOR INTERCOM, the verbal and foot operators branch to task 91, USE INTERCOM, and the cognitive and visual operators proceed to task 89, SCAN MAP DISPLAY. An assumption had to made here which will be continued through the rest of the modelling.

Due to the nature of SAINT, one operator cannot perform more than one task during the same time interval. However, from a practical viewpoint, the cognitive operator must be an integral part of each task. The modular approach offers a solution to this problem. If the mental operator is kept occupied through the module, it can be assumed that it is present and participating in each task.

The final task (task 102) in this network, as in all others, has CONDITIONAL, TAKE FIRST BRANCHING. This branching fits well in the scheme of modularity. By setting the branching conditions properly (this is already set for the user), branching will occur to the various modules as often as indicated without having to repeat the module as another entity.

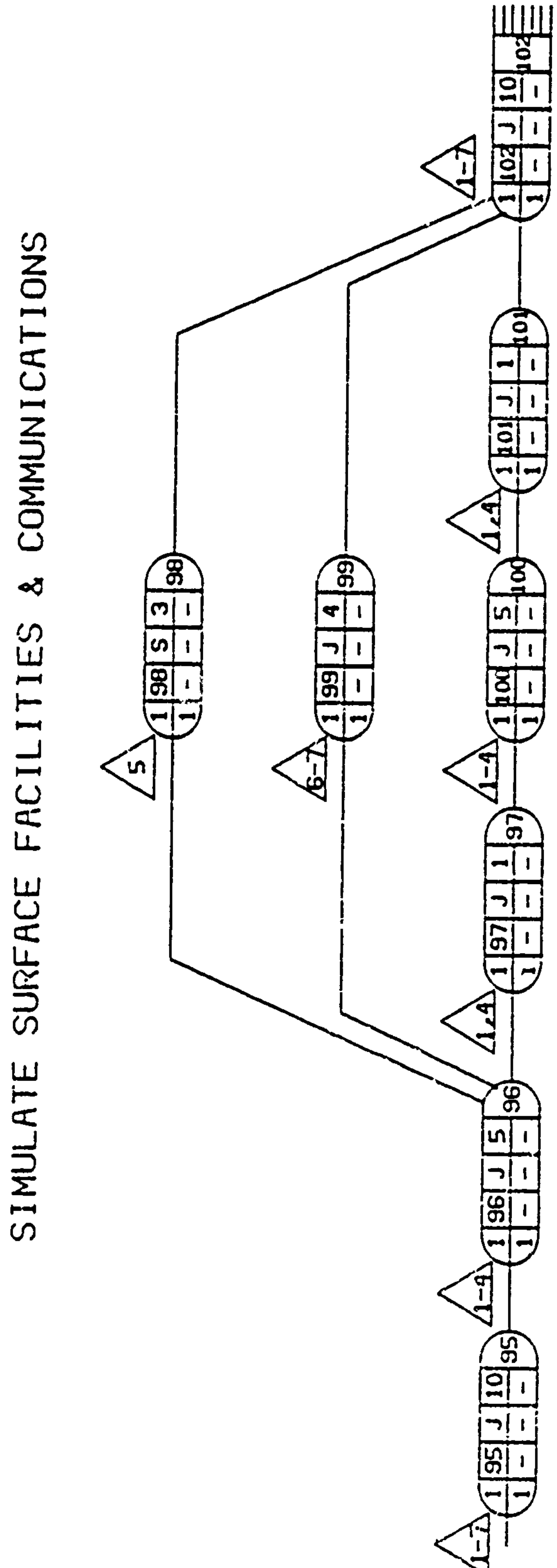



Figure 3-14 Module Flowchart

| INSTRUCTOR TASK DESCRIPTION | | A | D | IOS ACTIVITIES |
|---|---|---|---|---|
| SIMULATE SURFACE FACILITIES AND COMMUNICATIONS | | | | |
| | 95 | | | |
| Obtain onfirmation on surface scenario | 96 | | | Check Lesson Plan |
| Verify timing with respect to lesson plan | 97 | | | Scan map display to determine progress of training session |
| Receive message from crew | 98 | | | Monitor intercomm |
| Delivery message(s) to crew: responses or instructions | 99 | | | Use intercomm |
| Activate/De-activate simulated surface facilities and functions | 100 | | | Perform keyboard routine |
| Verify new situation | 101 | | | Scan mapping display |
| | 102 | | | |

Figure 3-15 ITD/Flowchart Correlation

3.3.6.2 Module Classification. The modules which form the RTP are divided into three classes.

3.3.6.2.1 Simulation Control Modules. These consist of all the actions an instructor must perform in order to run a simulation mission. Control modules are:

(a) Manage displays (i.e., calling up CRT pages, maps, etc).

(b) Brief crew and demonstrate maneuver.

(c) Simulate surface facilities and communications.

(d) Simulate ground support and communications.

(e) Simulate target area conditions and combat activities.

(f) Activate discrete malfunctions.

(g) Insert discrete malfunctions.

3.3.6.2.2 Assessment Modules. While having no effect on simulation, these are an integral part of the instructor work during a training mission. The instructor must assess trainee performance in various facets of flight. The IOS design and hardware have a great effect on the workload which the performance of these tasks imposes on the instructor. The assessment modules are:

(a) Assess accuracy of verbal communication

(b) Assess crew performance in continuous control activities, vehicle handling and flight path control

(c) Assess accuracy of navigation and ground track control

(d) Assess sequence of discrete activities

(e) Assess accuracy of discrete activities

(f) Assess crew cooperation

(g) Assess crew cooperation in combat maneuvers

(h) Assess crew performance in combat maneuvers

(i) Critique crew performance.

3.3.6.2.3 Documentation Modules. These afford the means of making formal written notes, hard copying the crew actions monitor display, hard copying an approach plot, or transferring data to disc files.

Each assessment module contains a task record of MAKE WRITTEN NOTES. This does not take the place of MAKE FORMAL WRITTEN NOTES in the documentation module. The notes taken during an assessment are merely "scribbles or jottings" which are often intelligible to only the instructor and used in the writing of formal notes.

3.3.6.2.4 <u>RTP Flowgraph</u>. Each division of modules was assigned a position in the RTP. The simulation control modules occupy the top line of the RTP flowgraph while the assessment modules and documentation modules occupy the second and third lines. This aids the user in quickly identifying the type of task being performed.

Figure 3-16 (from Appendix F) represents the flowgraph of RTP leg 4, implementing the module classifications. Each block represents a module of the ITD (to present the ITD module in its full form would increase the size of this drawing tenfold, making it cumbersome and confusing). Each oval represents a display management task. The top line of the flowgraph contains all simulation control tasks. The second line contains the assessment and display management tasks needed only for assessment purposes. Line three contains the documentation tasks. Figure 3-17, the verbal representation of leg 4 of the RTP, may be used as an aid in interpreting the flowgraph.

3.3.6.3 <u>Model Parameters</u>. Each task in the network has a set of task descriptors or parameters associated with it. A brief synopsis of each descriptor will be given here, and a full explanation is provided with the User's Guide, Appendix I. The task number is the identification number of a task in the network. No two tasks can have the same identification numbers. Task type is a code number indicating whether the task is performed by a single operator, joint operators, or by the equipment itself. Branching characteristics are code letters indicating whether the operators branch deterministically, probabilistically, or conditionally to another task. Release requirements indicate the number of tasks which must be completed before the task at hand is released (i.e., begun). There are two release requirements: one is the prerequisite for the first release of the task, and the other sets the requirements for any subsequent release of the same task. The parameter set number is the identification number (usually the same as the task number) of the parameter set associated with the task. Task class is an identification number between one and ten which identifies what group the task falls into. Figure 3-18 shows the descriptors as they will appear in a SAINT flowgraph.

The descriptors are rigidly set forth for the user in the data sets supplied for each TAM. These data sets are a presentation of the TAM data in the proper format for SAINT program processing. Data sets for each leg of the RTP are supplied to the user in Appendix D. The data sets for each of the 19 modules which comprise the RTP are presented in Appendix D under the same MODULE.DAT.

There are task descriptors within all these data which are subject to change by the user. They are:

(a) Task essentiality

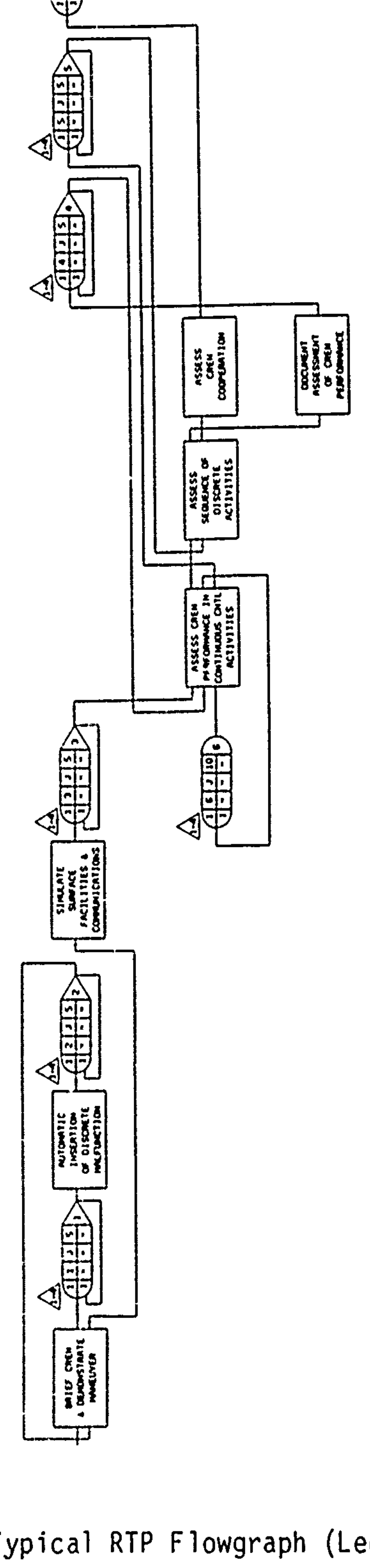



Figure 3-16 Typical RTP Flowgraph (Leg 4)

IOSS REPRESENTATIVE TASK PROFILE

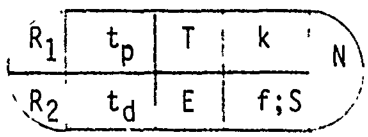
| | | ITL | LVDU | RVDU |
|---|---|---|---|---|
| 4.0 | TAKEOFF & DEPARTURE | | | |
| 4.1 | Takeoff | | P 50 | |
| 4.1.1 | Brief Crew for Mission Segment using Plan of Lesson | 3.1.2 | | |
| 4.1.2 | Call up Flight Instrument Display | | | P 600 |
| 4.1.3 | Arm Discrete Malfunction for Auto Insert<br>Engine Flameout LEFT<br>Relight Possible<br>To be auto inserted at 100 kts | 3.8.3 | P 30 | |
| 4.1.4 | Set up Mapping for Departure Assessment | 7.1 | | MAP |
| 4.1.5 | Reset TOTAL FREEZE | 3.7.1 | | |
| 4.1.6 | Simulate ATC Communications<br>Repeat Departure Messages from 3.3<br>Use Plan of Lesson for Data | 6.1.2 | | |
| 4.1.7 | Simulate Base Control Communications<br>Takeoff Clearance | 6.1.1 | | |
| 4.1.8 | Call Crew Actions Monitor Display<br>Call Styl. Inst. | | P 50 | P 600 |
| 4.2 | Engine Malfunction during Takeoff | | P 50 | P 600 |
| 4.2.1 | Assess Crew Performance in Vehicle Handling<br>Monitor Synthetic Flight Instruments<br>Monitor Crew Activity by CAM on line | <br>4.2.2<br>4.2.1 | <br>P 50 | <br>P 600<br>P 600 |
| 4.2.2 | Make written notes | 5.5.1 | | |
| 4.2.3 | Activate Discrete Malfunction (Ref)<br>(Automatic Insert at 100 kts) | | | |

Figure 3-17 RTP Leg 4 (1 of 2)

IOSS REPRESENTATIVE TASK PROFILE

| | | ITL | LVDU | RVDU |
|---|---|---|---|---|
| | TAKEOFF & DEPARTURE (Cont'd) | | | |
| 4.2.4 | Assess Sequence of Discrete Crew Actions | 4.2.1 | | |
| | Monitor CAM display on line | 4.2.1 | | P 600 |
| | Monitor Intercom Exchanges | 4.2.6 | P 50 | |
| 4.2.5 | Make written notes | 5.5.1 | | |
| 4.2.6 | Record Crew Actions Monitor Display | | P 600 | |
| 4.2.7 | Assess Crew Performance in Vehicle Handling | | | |
| | Monitor Synthetic Flight Instruments | 4.2.2 | P 50 | |
| 4.2.8 | Call up Map Display | | MAP | |
| 4.2.9 | Assess Flight Path Control Accuracy | | | |
| | Monitor Map Display | | | |
| 4.2.10 | Make written notes | 5.5.1 | | |
| | (Absence of Page 50) | | | |
| 4.3 | Climbout | | MAP | P 600 |
| 4.3.1 | Assess Flight Path Control Accuracy | 4.3 | | |
| | Monitor MAP Display during Departure | | | P 600 |
| | Monitor Synthetic Flight Instruments | | MAP | |
| 4.3.2 | Make written notes | 5.5.1 | | |
| 4.3.2 | Call Crew Actions Monitor Display | | P 50 | |
| 4.3.4 | Assess Sequence of Discrete Crew Actions | 4.2.1 | | |
| | Monitor Engine Relight Procedure by CAM | | P 50 | |
| 4.3.5 | Assess Crew Cooperation | 4.2.4 | | |
| | Monitor Intercomm Exchanges | 7.8 | | |

Figure 3-17 RTP Leg 4 (2 of 2)




N task number

$R_1$ number of releases required for first release of task N

$R_2$ number of releases required for subsequent release of task N

t time descriptors:

- $t_p$ parameter set number
- $t_d$ distribution type

T task type:

- S single operator task
- J joint task
- E either task
- Q equipment task
- C cyclic task
- F gap filler task

E task essentially ($0 \leq E \leq 1$)

k task class

f task adjustment factor

S task involved in data collection such as a mark node (S = M) or a statistics node (S = F, A, B, I, or D)

Figure 3-18 SAINT Flowgraph Descriptors (Copied from SAINT, Vol. 1)

(b) Values contained in the parameter set, NOT the parameter set number

(c) Distribution type

(d) Operator characteristics

(e) Time allotted to mission

Task essentiality is a number between 0.00 and 1.00 which indicates the importance of a task to a mission. If the mission is estimated by SAINT's benchmark iterations to run over the time allotted, tasks with the lower essentialities will be skipped, while tasks with an essentiality of 1.0 will always be performed. Parameter set values (i.e., mean, minimum and maximum times allowed for the completion of the task) will probably need to be changed with every engineering design change. Some parameter set values are supplied for the evaluation, cataloged (i.e., manual access, visual access) in the form of an index called PARAMINDX. DAT (Appendix G). The user will assign these values to the parameter set identification number already designated to the task. The distribution type is a code number identifying one of the 11 available types (paragraph 2.2.3.2.1) of time distributions into which the parameter set will fit.

Operator characteristics (e.g., speed, accuracy, stress threshold, and allotted time) are the final values subject to change by the evaluators.

3.3.6.3.1 Parameter Set Interchangeability. Each task has been assigned a parameter set identification number identical to the task identification number. These numbers range from 1 to 135. Parameter sets which contain parameters equal to zero have been numbered 200 to 250. Because the highest task number is 135, the user can quickly identify a parameter set numbered in the 200-series as a zero value parameter set able to be assigned to any task.

A task which has been assigned a zero value parameter set (200 to 250) is distinquished as a dormant task. This is the feature which allows the ITD to contain several methods of performing the same instructor task. The user need only identify which method applies to the IOS under study as active, and set the others dormant. The model processes the dormant tasks but they will not have an effect on the outcome of the mission.

SAINT can be used to change parameter sets by preprogrammed instructions. This feature allows the modular construction of the RTP to work. The 19 modules comprising the RTP are often repeated within each leg of the RTP. Sometimes in this repetition the user may want a dormant task to become active, or vice-versa. SAINT has capability to allow the completion of a designated task to trigger parameter set changes. That is, it can remove parameter sets by their identification number and replace them with another. Because SAINT removes parameter sets by their identification numbers, and not by the task they are assigned to, it was imperative to number each parameter set distinctly although the values in some sets may be equal (see User's Guide, Appendix I, for modification procedure).

3.3.6.4 Model Parameter Control. SAINT's parameter controls make possible a clear, concise, and simple method of keeping track of how parameter changes affect the model of a simulation.

Task parameter sets may be changed as the user sees fit. SAINT's output keeps track of these changes by providing a data echo check. This echo check sends back the data the user has specified in a labelled format, following the same data progression as the SAINT input specification with appropriate headings and explanations.

In the data echo check, the parameter set assigned to a task, the task type, the distribution type, and the assigned factors are labelled and shown (Figure 3-19). Any specified parameter set substitutions and the task which triggers such substitutions are also presented in the echo check. In the printout of the detailed iterations, both the time of replacement, the parameter set replaced and the new parameter set are flagged and printed (Figures 3-20). The length of time for which each operator was busy or idle is shown in the summary of iteration along with the maximum and minimum stress on each operator and the tasks on which these stress values occurred (Figure 3-21). The task summary report supplies the user with the number of times a task is released, failed, or skipped. The mean, minimum, maximum and standard of stress values on each task are also presented in this summary, as are the mean, minimum, maximum and standard of times tasks are realized and completed (Figure 3-22).

A task which holds a particular interest for the user can be designated a statistics task (see User's Guide, Appendix I) and will have a histogram along with a set of time statistics printed out for that task.

Use can be made of some of SAINT's categorizations to determine statistics of interest that are not calculated as such by SAINT. For example, if all manual access tasks have been designated as task type 2, and the user is interested in the total amount of time spent manually accessing devices, he/she need only sum the times of all type 2 tasks. If this becomes a common necessary parameter, the software can be adopted to calculate this particular value, or any other value of specific interest.

3.3.6.5 Model Outputs. SAINT's output is divided into benchmark iterations and run iterations.

3.3.6.5.1 Benchmark Iterations. The benchmark iteration output contains three sections:

(a) Echo Check of Input Data. See paragraph 3.3.6.4 and Figure 3-19. Portions of the input are detailed following the same data progression as the SAINT input specification with appropriate headings and explanations.

SAINT SIMULATION PROJECT 4 BY RTP3
DATE 9/ 5/ 1979

*RUN PARAMETERS*

NUMBER OF SINK TASKS IS 1
NUMBER OF TASKS TO REALIZE THE NETWORK IS 1
STATISTICS COLLECTED ON 1 TASKS
INITIAL RANDOM NUMBER SEED IS 9427615
SCALE FOR CONSTANT TIMES IS 1.0000
NUMBER OF RUN ITERATIONS REQUIRED IS 100
NUMBER OF BENCHMARK ITERATIONS IS 100

*PROGRAM OPTIONS*

| OPTION | CODE |
|---|---|
| NETWORK MODIFICATIONS | 0 |
| SERIAL MODIFICATIONS | 0 |
| CLEARING OF TASKS | 0 |
| CLEARING OF OPERATORS | 0 |
| PARAMETER MODIFICATIONS | 1 |
| HUMAN RADIATION DATA (READ) | 0 |
| HUMAN DECREMENT USE | 0 |
| EQUIPMENT DECREMENT USE | 0 |
| BENCHMARK ITERATIONS | 1 |
| BENCHMARK ITERATION CONDITION | 1 |
| BENCHMARK ITERATION PRINTED OUTPUT | 1 |
| BENCHMARK ITERATION PUNCHED OUTPUT | 1 |
| DETAILED BENCHMARK ITERATION OUTPUT (BEGIN) | 0 |
| DETAILED BENCHMARK ITERATION OUTPUT (END) | 0 |
| DETAILED ITERATION OUTPUT (BEGIN) | 1 |
| DETAILED ITERATION OUTPUT (END) | 1 |
| ITERATION SUMMARY (BEGIN) | 1 |
| ITERATION SUMMARY (END) | 1 |
| STATISTICAL OUTPUT | 1 |

*TASK PARAMETERS*

| PARAMETER NUMBER | PARAMETERS 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | 16.3000 | 0.0000 | 78.4000 | 5.2400 |
| 2 | 16.3000 | 0.0000 | 78.4000 | 5.2400 |
| 3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 4 | 15.7000 | 0.0000 | 78.4000 | 7.5100 |
| 5 | 12.0000 | 0.0000 | 93.7000 | 6.1900 |
| 6 | 15.3000 | 0.0000 | 78.4000 | 5.2400 |
| 7 | 16.3000 | 0.0000 | 78.4000 | 5.2400 |
| 8 | 12.0000 | 0.0000 | 93.7000 | 6.1900 |
| 9 | 16.3000 | 0.0000 | [illegible]000 | [illegible] |
| 10 | 7.9000 | 4.1000 | [illegible]00 | 1.2100 |
| 11 | 16.3000 | 0.0000 | [illegible]4000 | 5.2400 |
| 12 | 16.3000 | 0.0000 | 78.4000 | 5.2400 |
| 13 | 2[illegible]7000 | 16.0000 | 53.0000 | [illegible]2400 |
| 14 | 1[illegible]0000 | 0.0000 | 93.7000 | [illegible] |



Figure 3-19 Echo Check (1 of 5)

NETWORK DESCRIPTION

BRANCH KEY

D - DETERMINISTIC
P - PROBABILISTIC
M - MODIFIED PROBABILISTIC
F - CONDITIONAL TAKE FIRST
A - CONDITIONAL TAKE ALL

DISTRIBUTION KEY

1 CONSTANT
2 - NORMAL
3 UNIFORM
4 ERLANG
5 LOGNORMAL
6 POISSON
7 BETA
8 - GAMMA
9 THREE VALUED BETA
10 - SCALED CONSTANT
11 TRIANGULAR

STATISTICS KEY

F - TIME OF FIRST COMPLETION
A - TIME OF ALL COMPLETIONS
B - TIME BETWEEN COMPLETIONS
I - TIME INTERVAL BETWEEN TASKS
D - TIME DELAY
M - MARK NODE FOR TYPE 1 STATISTICS

| TASK NO | TASK TYPE | TASK ESS | PRED 1ST | COMPLETIONS SUBS | COMPLETIONS DIFF | BRANCH TYPE | DESIRED STATS | PARAM SET | DIST TYPE | ADJST FACTR | TASK CLASS | FACTORS INTEL | FACTORS MOTOR | FACTORS EQUIP | SUBS TASK | TASK OPERATORS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MULT | 1 00 | 1 | 1 | | P | | 1 | 2 | 0 00 | 5 | 0 | 0 | 0 | 0 | 1 2 3 4 |
| 2 | MULT | 1 00 | 1 | 1 | | P | | 2 | 2 | 0 00 | 5 | 0 | 0 | 0 | 0 | 1 2 3 4 |
| 3 | MULT | 1 00 | 1 | 1 | | D | | 3 | 2 | 0 00 | 5 | 0 | 0 | 0 | 0 | 1 2 3 4 |
| 4 | MULT | 1 00 | 1 | 1 | | P | | 4 | 2 | 0 00 | 5 | 0 | 0 | 0 | 0 | 1 2 3 4 |
| 5 | MULT | 1 00 | 1 | 1 | | P | | 5 | 2 | 0 00 | 5 | 0 | 0 | 0 | 0 | 1 2 3 4 |
| 6 | MULT | 1 00 | 1 | 1 | | P | | 6 | 2 | 0 00 | 5 | 0 | 0 | 0 | 0 | 1 2 3 4 |
| 7 | MULT | 1 00 | 1 | 1 | | P | | 8 | 2 | 0 00 | 5 | 0 | 0 | 0 | 0 | 1 2 3 4 |
| 77 | MULT | 1 00 | 0. | 1 | | D | | 200 | 2 | 0. 00 | 10 | 0 | 0 | 0 | 0 | 1 2 3 4 5 6 7 |
| 78 | MULT | 1 00 | 1 | 1 | | P | | 219 | 2 | 0 00 | 5 | 0 | 0 | 0 | 0 | 1 2 3 4 |
| 79 | MULT | 1 00 | 1 | 1 | | D | | 77 | 2 | 0 00 | 5 | 0 | 0 | 0 | 0 | 1 2 3 4 |
| 80 | MULT | 1 00 | 1 | 1 | | P | | 220 | 2 | 0 00 | 5 | 0 | 0 | 0 | 0 | 1 2 3 4 |
| 81 | MULT | 1 00 | 1 | 1 | | D | | 221 | 2 | 0 00 | 5 | 0 | 0 | 0 | 0 | 1 2 3 4 |
| 82 | MULT | 1 00 | 1 | 1 | | D | | 82 | 2 | 0 00 | 5 | 0 | 0 | 0 | 0 | 5 6 7 |
| 83 | MULT | 1 00 | 1 | 1 | | D | | 222 | 2 | 0 00 | 5 | 0 | 0 | 0 | 0 | 1 2 3 4 |
| 84 | MULT | 1 00 | 1 | 1 | | C | | 223 | 2 | 0 00 | 5 | 0 | 0 | 0 | 0 | 1 2 3 4 |
| 85 | MULT | 1 00 | 1 | 1 | | D | | 85 | 2 | 0 00 | 5 | 0 | 0 | 0 | 0 | 1 2 3 4 |
| 86 | MULT | 1 00 | 1 | 1 | | D | | 224 | 2 | 0 00 | 5 | 0 | 0 | 0 | 0 | 1 2 3 4 |
| 88 | MULT | 1 00 | 1 | 1 | | F | | 201 | 2 | 0 00 | 10 | 0 | 0 | 0 | 0 | 1 2 3 4 5 6 7 |
| 42 | MULT | 1 00 | 1 | 1 | | D | | 202 | 2 | 0 00 | 10 | 0 | 0 | 0 | 0 | 1 2 3 4 5 6 7 |
| 43 | SING | 1 00 | 1 | 1 | | D | | 43 | 2 | 0 00 | 1 | 0 | 0 | 0 | 0 | 1 |
| 44 | SING | 1 00 | 1 | 1 | | D | | 44 | 2 | 0 00 | 3 | 0 | 0 | 0 | 0 | 5 |
| 45 | MULT | 1 00 | 1 | 1 | | D | | 45 | 2 | 0 00 | 2 | 0 | 0 | 0 | 0 | 2 3 |
| 46 | SING | 1 00 | 1 | 1 | | D | | 46 | 2 | 0 00 | 1 | 0 | 0 | 0 | 0 | 1 |
| 47 | SING | 1 00 | 1 | 1 | | D | | 47 | 2 | 0 00 | 7 | 0 | 0 | 0 | 0 | 4 |
| 48 | MULT | 1 00 | 1 | 1 | | F | | 203 | 2 | 0 00 | 10 | 0 | 0 | 0 | 0 | 1 2 3 4 5 6 7 |
| 34 | MULT | 1 00 | 1 | 1 | | D | | 204 | 2 | 0 00 | 10 | 0 | 0 | 0 | 0 | 1 2 3 4 5 6 7 |
| 35 | SING | 1 00 | 1 | 1 | | D | | 35 | 2 | 0 00 | 3 | 0 | 0 | 0 | 0 | 5 |
| 36 | SING | 1 00 | 1 | 1 | | D | | 36 | 2 | 0 00 | 1 | 0 | 0 | 0 | 0 | 1 |
| 37 | SING | 1 00 | 1 | 1 | | D | | 37 | 2 | 0 00 | 1 | 0 | 0 | 0 | 0 | 1 |
| 38 | MULT | 1 00 | 1 | 1 | | D | | 38 | 2 | 0 00 | 2 | 0 | 0 | 0 | 0 | 2 3 |
| 39 | SING | 1 00 | 1 | 1 | | D | | 39 | 2 | 0 00 | 2 | 0 | 0 | 0 | 0 | 1 |
| 40 | SING | 1 00 | 1 | 1 | | D | | 40 | 2 | 0 00 | 7 | 0 | 0 | 0 | 0 | 4 |
| 41 | MULT | 1 00 | 1 | 1 | | F | | 205 | 2 | 0 00 | 10 | 0 | 0 | 0 | 0 | 1 2 3 4 5 6 7 |
| 49 | MULT | 1 00 | 1 | 1 | | D | | 206 | 2 | 0 00 | 10 | 0 | 0 | 0 | 0 | 1 2 3 4 5 6 7 |
| 50 | SING | 1 00 | 1 | 1 | | D | | 50 | 2 | 0 00 | 1 | 0 | 0 | 0 | 0 | 1 |
| 51 | SING | 1 00 | 1 | 1 | | D | | 51 | 2 | 0 00 | 3 | 0 | 0 | 0 | 0 | 5 |
| 52 | SING | 1 00 | 1 | 1 | | D | | 225 | 2 | 0 00 | 1 | 0 | 0 | 0 | 0 | [illegible] |
| 53 | MULT | 1 00 | 1 | 1 | | D | | 53 | 2 | 0 00 | [illegible] | 0 | 0 | 0 | 0 | 2 3 |
| 54 | SING | 1 00 | 1 | 1 | | D | | 54 | 2 | 0 00 | 1 | 0 | 0 | 0 | 0 | 1 |
| 55 | SING | 1 00 | 1 | 1 | | D | | 55 | 2 | 0 00 | 7 | 0 | 0 | 0 | 0 | 4 |
| 55 | MULT | 1 00 | 1 | 1 | | F | | [illegible]7 | 2 | 0 00 | 10 | 0 | 0 | 0 | [illegible] | 1 2 3 4 5 6 7 |
| 25 | MULT | 1 00 | 1 | 1 | | D | | [illegible] | 2 | 0 00 | 10 | 0 | 0 | 0 | [illegible] | 1 2 3 4 5 6 7 |



Figure 3-19 Echo Check (2 of 5)

PRECEDENCE RELATIONS

BRANCH KEY
D DETERMINISTIC
P PROBABILISTIC
M MODIFIED PROBABILISTIC
F CONDITIONAL - TAKE FIRST
A CONDITIONAL - TAKE ALL

CONDITION KEY
1 - SPECIFIED TASK COMPLETED
2 - TIME LE SPECIFIED TIME
3 - SPECIFIED TASK NOT COMPLETED
4 - TIME GT SPECIFIED TIME

| TASK NUMBER | BRANCH TYPE | BRANCHING CHARACTERISTICS SUCC TASK | PROB/ COND | MODE/ VALUE | SUCC TASK | PROB/ COND | MODE/ VALUE | SUCC TASK | PROB/ COND | MODE/ VALUE | SUCC TASK | PROB/ COND | MODE/ VALUE | SUCC TASK | PROB/ COND | MODE/ VALUE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | P | 2 | 0.750 | | 1 | 0.250 | | | | | | | | | | |
| 2 | P | 42 | 0.750 | | 2 | 0.250 | | | | | | | | | | |
| 3 | D | 103 | | | | | | | | | | | | | | |
| 4 | P | 117 | 0.970 | | 4 | 0.030 | | | | | | | | | | |
| 5 | P | 6 | 0.880 | | 5 | 0.120 | | | | | | | | | | |
| 6 | P | 117 | 0.750 | | 6 | 0.250 | | | | | | | | | | |
| 7 | P | 42 | 0.750 | | 7 | 0.250 | | | | | | | | | | |
| 26 | D | 27 | | | 28 | | | 31 | | | 32 | | | | | |
| 27 | D | 29 | | | | | | | | | | | | | | |
| 28 | D | 33 | | | | | | | | | | | | | | |
| 29 | D | 30 | | | | | | | | | | | | | | |
| 30 | D | 33 | | | | | | | | | | | | | | |
| 31 | D | 33 | | | | | | | | | | | | | | |
| 32 | D | 33 | | | | | | | | | | | | | | |
| 33 | F | 89 | 3 | 39.00 | 42 | 3 | 5.00 | | | | | | | | | |
| 34 | D | 35 | | | 36 | | | 38 | | | 40 | | | | | |
| 35 | D | 41 | | | | | | | | | | | | | | |
| 36 | D | 37 | | | | | | | | | | | | | | |
| 37 | D | 39 | | | | | | | | | | | | | | |
| 38 | D | 41 | | | | | | | | | | | | | | |
| 39 | D | 41 | | | | | | | | | | | | | | |
| 40 | D | 41 | | | | | | | | | | | | | | |
| 41 | F | 47 | 3 | 42.00 | 67 | 3 | 8.00 | | | | | | | | | |
| 42 | D | 43 | | | 44 | | | 45 | | | 47 | | | | | |
| 43 | D | 46 | | | | | | | | | | | | | | |
| 44 | D | 48 | | | | | | | | | | | | | | |
| 45 | D | 48 | | | | | | | | | | | | | | |
| 46 | D | 48 | | | | | | | | | | | | | | |
| 47 | D | 48 | | | | | | | | | | | | | | |
| 48 | F | 34 | 3 | 34.00 | 47 | 3 | 4.00 | 36 | 3. | 5.00 | 49 | 3. | 25.00 | | | |
| 49 | D | 50 | | | 51 | | | 53 | | | 55 | | | | | |
| 50 | D | 52 | | | | | | | | | | | | | | |
| 51 | D | 56 | | | | | | | | | | | | | | |
| 52 | D | 54 | | | | | | | | | | | | | | |
| 53 | D | 56 | | | | | | | | | | | | | | |
| 54 | D | 56 | | | | | | | | | | | | | | |
| 55 | D | 56 | | | | | | | | | | | | | | |
| 56 | F | 26 | 3. | 26.00 | 4 | 3. | 4.00 | 82 | 3. | 5.00 | 75 | 3. | 25.00 | | | |
| 67 | D | 68 | | | 73 | | | 75 | | | | | | | | |
| 68 | D | 69 | | | 74 | | | | | | | | | | | |
| 69 | D | 70 | | | | | | | | | | | | | | |
| 70 | D | 71 | | | | | | | | | | | | | | |
| 71 | D | 72 | | | | | | | | | | | | | | |
| 72 | D | 74 | | | | | | | | | | | | | | |
| 73 | D | 76 | | | | | | | | | | | | | | |
| 74 | D | 76 | | | | | | | | | | | | | | |
| 75 | D | 76 | | | | | | | | | | | | | | |
| 76 | F | 60 | 3 | 8.00 | | | | | | | | | | | | |

Figure 3-19 Echo Check (3 of 5)

SPECIAL NETWORK CHARACTERISTICS

*SOURCE TASK NUMBERS*

22

*SINK TASK NUMBERS*

8

*PARAMETER MODIFICATIONS*

| TASK NUMBER | PARAM OUT | PARAM IN | PARAM OUT | PARAM IN | PARAM OUT | PARAM IN | PARAM OUT | PARAM IN |
|---|---|---|---|---|---|---|---|---|
| 89 | 50 | 230 | | | | | | |
| 4 | 230 | 50 | 104 | 233 | 106 | 234 | | |
| 3 | 231 | 119 | | | | | | |
| 7 | 54 | 235 | 36 | 239 | 37 | 240 | | |

Figure 3-19 Echo Check (4 of 5)

OPERATOR DESCRIPTION

| OPERATOR NUMBER | STRESS THRESHOLD | OPERATOR SPEED | OPERATOR ACCURACY | TIME ALLOTTED | GOAL GRADIENT | INTERMEDIATE STRESS POINTS TASK | TIME | TASK | TIME | TASK | TIME | TASK | TIME | TASK | TIME |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.50 | 1.00 | 1.00 | 1060.00 | 0.75 | 60 | 1590.0 | | | | | | | | |
| 2 | 2.50 | 1.00 | 1.00 | 1060.00 | 0.75 | 60 | 1590.0 | | | | | | | | |
| 3 | 2.50 | 1.00 | 1.00 | 1060.00 | 0.75 | 60 | 1590.0 | | | | | | | | |
| 4 | 2.50 | 1.00 | 1.00 | 1060.00 | 0.75 | 60 | 1590.0 | | | | | | | | |
| 5 | 2.50 | 1.00 | 1.00 | 1060.00 | 0.75 | 60 | 1590.0 | | | | | | | | |
| 6 | 2.50 | 1.00 | 1.00 | 1060.00 | 0.75 | 60 | 1590.0 | | | | | | | | |
| 7 | 2.50 | 1.00 | 1.00 | 1060.00 | 0.75 | 60 | 1590.0 | | | | | | | | |

Figure 3-19 Echo Check (5 of 5)

SPECIAL NETWORK CHARACTERISTICS

*SOURCE TASK NUMBERS*

77

*SINK TASK NUMBERS*

8

*PARAMETER MODIFICATIONS*

| TASK NUMBER | PARAM OUT | PARAM IN | PARAM OUT | PARAM IN | PARAM OUT | PARAM IN | PARAM OUT | PARAM IN |
|---|---|---|---|---|---|---|---|---|
| 89 | 50 | 230 | | | | | | |
| 4 | 230 | 50 | 104 | 233 | 106 | 234 | | |
| 3 | 231 | 119 | | | | | | |
| 7 | 54 | 235 | 36 | 239 | 37 | 240 | | |

Figure 3-19 Echo Check (4 of 5)

OPERATOR DESCRIPTION

| OPERATOR NUMBER | STRESS THRESHOLD | OPERATOR SPEED | OPERATOR ACCURACY | TIME ALLOTTED | GOAL GRADIENT | TASK | TIME | TASK | TIME | TASK | TIME | TASK | TIME | TASK | TIME |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | INTERMEDIATE STRESS POINTS | | | | | | |
| 1 | 2.50 | 1.00 | 1.00 | 1860.00 | 0.75 | 60 | 1590.0 | | | | | | | | |
| 2 | 2.50 | 1.00 | 1.00 | 1860.00 | 0.75 | 60 | 1590.0 | | | | | | | | |
| 3 | 2.50 | 1.00 | 1.00 | 1860.00 | 0.75 | 60 | 1590.0 | | | | | | | | |
| 4 | 2.50 | 1.00 | 1.00 | 1860.00 | 0.75 | 60 | 1590.0 | | | | | | | | |
| 5 | 2.50 | 1.00 | 1.00 | 1860.00 | 0.75 | 60 | 1590.0 | | | | | | | | |
| 6 | 2.50 | 1.00 | 1.00 | 1860.00 | 0.75 | 60 | 1590.0 | | | | | | | | |
| 7 | 2.50 | 1.00 | 1.00 | 1860.00 | 0.75 | 60 | 1590.0 | | | | | | | | |

Figure 3-19 Echo Check (5 of 5)

DETAILED OUTPUT OF ITERATION NUMBER 1

| TASK NUMBER | TASK TYPE | TASK [illegible] | START TIME | EXPECTED END TIME | RLC PROB | NOD PROB | [illegible] | TASK STRESS | OPERATOR STRESS VALUES 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 | MULT | 1.0 | 0.00 | 0.00 | 1.000 | 1.000 | 0.00 | 1.00 | *1.00 | *1.00 | *1.00 | *1.00 | *1.00 | *1.00 | *1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 78 | MULT | 1.0 | 0.00 | 0.00 | 0.750 | 0.750 | 0.00 | 1.00 | *1.00 | *1.00 | *1.00 | *1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 79 | MULT | 1.0 | 0.00 | 32.60 | 1.000 | 1.000 | 0.00 | 1.00 | *1.00 | *1.00 | *1.00 | *1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 80 | MULT | 1.0 | 32.60 | 32.60 | 0.750 | 0.750 | 0.00 | 1.00 | *1.00 | *1.00 | *1.00 | *1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 81 | MULT | 1.0 | 32.60 | 32.60 | 1.000 | 1.000 | 0.00 | 1.00 | *1.00 | *1.00 | *1.00 | *1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 82 | MULT | 1.0 | 32.60 | 61.61 | 1.000 | 1.000 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | *1.00 | *1.00 | *1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 83 | MULT | 1.0 | 32.60 | 32.60 | 1.000 | 1.000 | 0.00 | 1.00 | *1.00 | *1.00 | *1.00 | *1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 84 | MULT | 1.0 | 32.60 | 32.60 | 0.750 | 0.750 | 0.00 | 1.00 | *1.00 | *1.00 | *1.00 | *1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 85 | MULT | 1.0 | 32.60 | 50.05 | 1.000 | 1.000 | 0.00 | 1.00 | *1.00 | *1.00 | *1.00 | *1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 86 | MULT | 1.0 | 50.05 | 50.05 | 1.000 | 1.000 | 0.00 | 1.00 | *1.00 | *1.00 | *1.00 | *1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 88 | MULT | 1.0 | 61.61 | 61.61 | 1.000 | 1.000 | 0.00 | 1.00 | *1.00 | *1.00 | *1.00 | *1.00 | *1.00 | *1.00 | *1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1 | MULT | 1.0 | 61.61 | 76.93 | 0.750 | 0.751 | 0.50 | 1.00 | *1.00 | *1.00 | *1.00 | *1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | MULT | 1.0 | 76.93 | 96.25 | 0.750 | 0.750 | 0.00 | 1.00 | *1.00 | *1.00 | *1.00 | *1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 42 | MULT | 1.0 | 96.25 | 96.25 | 1.000 | 1.000 | 0.00 | 1.00 | *1.00 | *1.00 | *1.00 | *1.00 | *1.00 | *1.00 | *1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 45 | MULT | 1.0 | 96.25 | 135.97 | 1.000 | 1.000 | 0.00 | 1.00 | 1.00 | *1.00 | *1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 43 | SING | 1.0 | 96.25 | 125.00 | 1.000 | 1.000 | 0.00 | 1.00 | *1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 44 | SING | 1.0 | 96.25 | 156.11 | 1.000 | 1.000 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | *1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 47 | SING | 1.0 | 96.25 | 156.05 | 1.000 | 1.000 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | *1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 46 | SING | 1.0 | 125.00 | 185.93 | 1.000 | 1.000 | 0.00 | 1.00 | *1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 48 | MULT | 1.0 | 185.93 | 185.93 | 1.000 | 1.000 | 0.00 | 1.02 | *1.00 | *1.00 | *1.00 | *1.02 | *1.00 | *1.00 | *1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 14 | MULT | 1.0 | 185.93 | 185.93 | 1.000 | 1.000 | 0.00 | 1.02 | *1.00 | *1.00 | *1.00 | *1.02 | *1.00 | *1.00 | *1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 81 | MULT | 1.0 | 185.93 | 274.50 | 1.000 | 1.000 | 0.00 | 1.01 | 1.00 | *1.00 | *1.00 | 1.02 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 33 | SING | 1.0 | 185.93 | 273.07 | 1.000 | 1.000 | 0.00 | 1.01 | 1.00 | 1.0 | 1.00 | 1.02 | *1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 36 | SING | 1.0 | 185.93 | 216.29 | 1.000 | 1.000 | 0.00 | 1.01 | *1.00 | 1.00 | 1.00 | 1.02 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 40 | SING | 1.0 | 185.93 | 274.14 | 1.000 | 1.000 | 0.00 | 1.02 | 1.00 | 1.00 | 1.00 | *1.02 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 17 | SING | 1.0 | 216.29 | 248.06 | 1.000 | 1.000 | 0.00 | 1.01 | *1.00 | 1.00 | 1.00 | 1.02 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 19 | SING | 1.0 | 248.06 | 278.48 | 1.000 | 1.000 | 0.00 | 1.01 | *1.00 | 1.00 | 1.00 | 1.02 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 41 | MULT | 1.0 | 278.48 | 278.48 | 1.000 | 1.000 | 0.00 | 1.02 | *1.00 | *1.00 | *1.00 | *1.02 | *1.00 | *1.00 | *1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 42 | MULT | 1.0 | 278.48 | 278.48 | 1.000 | 1.000 | 0.00 | 1.02 | *1.00 | *1.00 | *1.00 | *1.02 | *1.00 | *1.00 | *1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 53 | MULT | 1.0 | 278.48 | 337.17 | 1.000 | 1.000 | 0.00 | 1.01 | 1.00 | *1.00 | *1.00 | 1.02 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 50 | SING | 1.0 | 278.48 | 310.15 | 1.000 | 1.000 | 0.00 | 1.01 | *1.00 | 1.00 | 1.00 | 1.02 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 51 | SING | 1.0 | 278.48 | 337.15 | 1.000 | 1.000 | 0.00 | 1.01 | 1.00 | 1.00 | 1.00 | 1.02 | *1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 55 | SING | 1.0 | 278.48 | 335.97 | 1.000 | 1.000 | 0.00 | 1.02 | 1.00 | 1.00 | 1.00 | *1.02 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 52 | SING | 1.0 | 310.15 | 310.15 | 1.000 | 1.000 | 0.00 | 1.01 | *1.00 | 1.00 | 1.00 | 1.02 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 54 | SING | 1.0 | 310.15 | 340.10 | 1.000 | 1.000 | 0.00 | 1.01 | *1.00 | 1.00 | 1.00 | 1.02 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 56 | MULT | 1.0 | 340.10 | 340.10 | 1.000 | 1.000 | 0.00 | 1.02 | *1.00 | *1.00 | *1.00 | *1.02 | *1.00 | *1.00 | *1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 26 | MULT | 1.0 | 340.10 | 340.10 | 1.000 | 1.000 | 0.00 | 1.02 | *1.00 | *1.00 | *1.00 | *1.02 | *1.00 | *1.00 | *1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 11 | MULT | 1.0 | 340.10 | 398.03 | 1.000 | 1.000 | 0.00 | 1.02 | 1.00 | *1.00 | *1.00 | 1.02 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 27 | SING | 1.0 | 340.10 | 368.91 | 1.000 | 1.000 | 0.00 | 1.02 | *1.00 | 1.00 | 1.00 | 1.02 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 28 | SING | 1.0 | 340.10 | 398.65 | 1.000 | 1.000 | 0.00 | 1.02 | 1.00 | 1.00 | 1.00 | 1.02 | *1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 32 | SING | 1.0 | 340.10 | 397.01 | 1.000 | 1.000 | 0.00 | 1.02 | 1.00 | 1.00 | 1.00 | *1.02 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 29 | SING | 1.0 | 368.91 | 368.91 | 1.000 | 1.000 | 0.00 | 1.02 | *1.00 | 1.00 | 1.00 | 1.02 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 30 | SING | 1.0 | 368.91 | 398.03 | 1.000 | 1.000 | 0.00 | 1.02 | *1.00 | 1.00 | 1.00 | 1.02 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 44 | MULT | 1.0 | 398.03 | 398.03 | 1.000 | 1.000 | 0.00 | 1.03 | *1.00 | *1.00 | *1.00 | *1.03 | *1.00 | *1.00 | *1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 87 | MULT | 1.0 | 398.03 | 398.03 | 1.000 | 1.000 | 0.00 | 1.03 | *1.00 | *1.00 | *1.00 | *1.03 | *1.00 | *1.00 | *1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| -- *PARAMETER SET 50 REPLACED BY PARAMETER SET 230 AT TIME 398.03**** | | | | | | | | | | | | | | | | | | | |
| 70 | MULT | 1.0 | 398.03 | 456.37 | 1.000 | 1.000 | 0.00 | 1.03 | *1.00 | *1.00 | *1.00 | *1.03 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 91 | MULT | 1.0 | 456.39 | 463.90 | 1.000 | 1.000 | 0.00 | 1.02 | *1.00 | *1.00 | *1.00 | *1.02 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 92 | MULT | 1.0 | 463.90 | 463.90 | 1.000 | 1.000 | 0.00 | 1.02 | *1.00 | *1.00 | *1.00 | *1.02 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 93 | MULT | 1.0 | 463.90 | 463.90 | 1.000 | 1.000 | 0.00 | 1.02 | *1.00 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 94 | MULT | 1.0 | 463.90 | 463.90 | 1.000 | 1.000 | 0.00 | 1.02 | *1.00 | [illegible] | [illegible] | *1.02 | *1.00 | *1.00 | *1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 103 | MULT | 1.0 | 463.90 | 463.90 | 1.000 | 1.000 | 0.00 | 1.02 | *1.00 | [illegible] | [illegible] | *1.02 | *1.00 | *1.00 | *1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 101 | MULT | 1.0 | 463.90 | 485.04 | 1.000 | 1.000 | 0.00 | 1.02 | *1.00 | *1.00 | 1.00 | *1.02 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 102 | [illegible] | 1.0 | 463.90 | 487.41 | 1.000 | 1.000 | [illegible] | 1.02 | 1.00 | 1.00 | 1.00 | 1.02 | *1.0[illegible] | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 105 | [illegible] | 1.0 | 485.04 | 485.04 | 1.000 | 1.000 | 0.00 | 1.02 | *1.00 | *1.00 | *1.00 | *1.02 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |



Figure 3-20 Detail Output

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41 | MUL1 | 1 0 | 1410.33 | 1410.33 | 1.000 | 1.000 | 0.00 | 5.00 | *5.00 | *4.66 | *4.56 | *5.00 | *3.16 | *2.50 | *2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 67 | MUL1 | 1 0 | 1410.33 | 1410.33 | 1.000 | 1.000 | 0.00 | 2.50 | *1.00 | *1.00 | *1.00 | *2.50 | *2.50 | *2.50 | *2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 68 | MUL1 | 1 0 | 1410.33 | 1413.72 | 1.000 | 1.000 | 0.29 | 2.00 | *1.00 | *1.00 | *1.00 | 2.50 | 2.50 | 2.50 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 73 | MUL1 | 1 0 | 1410.33 | 1457.33 | 1.000 | 1.000 | 1.00 | 3.50 | 1.00 | 1.00 | 1.00 | *2.50 | *2.50 | *2.50 | *2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 75 | SING | 1 0 | 1410.33 | 1658.97 | 1.000 | 1.000 | 1.00 | 3.50 | 1.00 | 1.00 | 1.00 | *2.50 | 2.50 | 2.50 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 69 | SING | 1.0 | 1413.72 | 1631.90 | 1.000 | 1.000 | 0.29 | 2.00 | *1.00 | 1.00 | 1.00 | 2.50 | 2.50 | 2.50 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 70 | SING | 1 0 | 1531.90 | 1631.90 | 1.000 | 1.000 | 0.29 | 2.00 | *1.00 | 1.00 | 1.00 | 2.50 | 2.50 | 2.50 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 71 | SING | 1 0 | 1531.90 | 1631.90 | 1.000 | 1.000 | 0.29 | 2.00 | *1.00 | 1.00 | 1.00 | 2.50 | 2.50 | 2.50 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 72 | SING | 1 0 | 1531.90 | 1644.83 | 1.000 | 1.000 | 0.29 | 2.00 | *1.00 | 1.00 | 1.00 | 2.50 | 2.50 | 2.50 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 74 | MUL1 | 1 0 | 1544.83 | 1658.73 | 1.000 | 1.000 | 0.29 | 2.00 | *1.00 | *1.00 | *1.00 | 2.50 | 2.50 | 2.50 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 76 | MUL1 | 1 0 | 1558.97 | 1658.97 | 1.000 | 1.000 | 0.00 | 2.50 | *1.00 | *1.00 | *1.00 | *2.50 | *2.50 | *2.50 | *2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 89 | MUL1 | 1 0 | 1558.97 | 1658.97 | 1.000 | 1.000 | 0.00 | 5.00 | *5.00 | *5.00 | *5.00 | *5.00 | *3.33 | *2.50 | *2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 90 | MUL1 | 1 0 | 1558.97 | 1779.32 | 1.000 | 1.000 | 2.99 | 5.00 | *5.00 | *5.00 | *5.00 | *5.00 | 3.33 | 2.50 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 91 | MUL1 | 1 0 | 1779.32 | 1796.57 | 1.000 | 1.000 | 2.99 | 5.00 | *5.00 | *5.00 | *5.00 | *5.00 | 3.33 | 2.50 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 92 | MUL1 | 1 0 | 1796.57 | 1796.57 | 1.000 | 1.000 | 2.99 | 5.00 | *5.00 | *5.00 | *5.00 | *5.00 | 3.33 | 2.50 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 93 | MUL1 | 1 0 | 1796.57 | 1796.57 | 1.000 | 1.000 | 2.99 | 5.00 | *5.00 | *5.00 | *5.00 | *5.00 | 3.33 | 2.50 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 94 | MUL1 | 1 0 | 1796.57 | 1796.57 | 1.000 | 1.000 | 0.00 | 5.00 | *5.00 | *5.00 | *5.00 | *5.00 | *5.00 | *2.88 | *2.88 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0 | MUL1 | 1 0 | 1796.57 | 1817.11 | 1.000 | 1.000 | 2.19 | 3.50 | *1.00 | *1.00 | *1.00 | *2.50 | 5.00 | 2.88 | 2.88 | 0.00 | 0.00 | 0.00 | 0.00 |

SUMMARY OF ITERATION NUMBER 1

| OPERATOR NUMBER | TIME- AVAIL | BUSY | IDLE | USED | STRESS- MEAN | STD | MIN | TASK | MAX | TASK |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1850.00 | 1402.33 | 414.78 | 1817.11 | 2.03 | 1.47 | 1.00 | 77 | 5.00 | 34 |
| 2 | 1850.00 | 1418.11 | 398.99 | 1817.11 | 1.98 | 1.49 | 1.00 | 77 | 5.00 | 34 |
| 3 | 1850.00 | 1396.15 | 420.96 | 1817.11 | 1.97 | 1.49 | 1.00 | 77 | 5.00 | 34 |
| 4 | 1850.00 | 1597.85 | 219.85 | 1817.11 | 2.32 | 1.49 | 1.00 | 77 | 5.00 | 36 |
| 5 | 1850.00 | 995.77 | 810.90 | 1796.57 | 1.77 | 1.28 | 1.00 | 77 | 5.00 | 34 |
| 6 | 1850.00 | 208.27 | 1598.30 | 1796.57 | 1.17 | 0.45 | 1.00 | 77 | 2.88 | 94 |
| 7 | 1850.00 | 208.27 | 1598.30 | 1796.57 | 1.17 | 0.45 | 1.00 | 77 | 2.88 | 94 |

AVERAGE MISSION COHESIVENESS 0.977
MISSION SUCCESSFUL

Figure 3-21 Iteration Summary

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK NO | TASK TYPE | TASK LSS | COUNTERS REL | FAIL | SKIP | TIME TASK REALIZED MEAN | STD | MIN | MAX | TIME TASK COMPLETED MEAN | STD. | MIN | MAX | TASK STRESS MEAN | STD | MIN | MAX | TASK COHESIVENESS MEAN | STD. | MIN | MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MULT | 1.00 | 140 | 40 | 0 | 67.7 | 11.65 | 58.0 | 114.3 | 84.0 | 11.84 | 65.8 | 129.2 | 1.01 | 0.01 | 1.00 | 1.04 | 0.00 | 0.00 | 0.00 | 0.01 |
| 2 | MULT | 1.00 | 127 | 27 | 0 | 98.5 | 15.26 | 65.8 | 132.9 | 104.5 | 15.82 | 76.2 | 149.4 | 1.01 | 0.01 | 1.00 | [illegible] | 0.00 | 0.00 | 0.00 | 0.01 |
| 3 | MULT | 1.00 | 100 | 0 | 0 | 931.6 | 17.67 | 903.5 | 1009.0 | 931.6 | 17.69 | 903.5 | 1009.0 | 1.00 | 0.01 | 1.00 | 1.07 | 0.00 | 0.00 | 0.00 | 0.02 |
| 4 | MULT | 1.00 | 103 | 3 | 0 | 656.1 | 10.29 | 635.9 | 693.9 | 671.5 | 12.77 | 649.2 | 703.9 | 1.01 | 0.01 | 1.00 | 1.03 | 0.00 | 0.00 | 0.00 | 0.01 |
| 5 | MULT | 1.00 | 108 | 8 | 0 | 950.9 | 18.25 | 927.9 | 1035.6 | 969.5 | 18.08 | 935.5 | 1043.5 | 1.02 | 0.02 | 1.00 | 1.11 | 0.00 | 0.01 | 0.00 | 0.03 |
| 6 | MULT | 1.00 | 136 | 36 | 0 | 975.1 | 22.52 | 935.5 | 1046.0 | 991.4 | 23.34 | 940.0 | 1062.2 | 1.02 | 0.02 | 1.00 | 1.11 | 0.00 | 0.01 | 0.00 | 0.03 |
| 7 | MULT | 1.00 | 148 | 48 | 0 | 1056.6 | 26.91 | 1009.2 | 1132.0 | 1069.8 | 29.27 | 1015.2 | 1149.2 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 8 | MULT | 1.00 | 100 | 0 | 0 | 1821.1 | 22.86 | 1772.6 | 1874.6 | 1847.0 | 30.06 | 1765.2 | 1927.2 | 3.58 | 0.33 | 3.50 | 5.00 | 2.31 | 0.52 | 2.19 | 4.57 |
| 26 | MULT | 1.00 | 200 | 0 | 0 | 573.0 | 227.52 | 318.0 | 874.3 | 573.0 | 227.52 | 318.0 | 874.3 | 1.33 | 0.30 | 1.01 | 1.79 | 0.00 | 0.00 | 0.00 | 0.00 |
| 27 | SING | 1.00 | 200 | 0 | 0 | 573.0 | 227.52 | 318.0 | 874.3 | 595.4 | 220.81 | 348.3 | 892.3 | 1.37 | 0.35 | 1.00 | 1.97 | 0.11 | 0.10 | 0.00 | 0.30 |
| 28 | SING | 1.00 | 200 | 0 | 0 | 573.0 | 227.52 | 318.0 | 874.3 | 620.0 | 216.37 | 377.4 | 907.5 | 1.22 | 0.20 | 1.00 | 1.55 | 0.06 | 0.06 | 0.00 | 0.16 |
| 29 | SING | 1.00 | 200 | 0 | 0 | 596.4 | 220.91 | 348.3 | 892.3 | 595.4 | 220.81 | 348.3 | 892.3 | 1.36 | 0.35 | 1.00 | 1.96 | 0.11 | 0.10 | 0.00 | 0.30 |
| 30 | SING | 1.00 | 200 | 0 | 0 | 596.4 | 220.91 | 348.3 | 892.3 | 619.6 | 214.09 | 370.1 | 909.3 | 1.36 | 0.35 | 1.00 | 1.96 | 0.11 | 0.10 | 0.00 | 0.30 |
| 31 | MULT | 1.00 | 200 | 0 | 0 | 573.0 | 227.52 | 318.0 | 874.3 | 618.1 | 214.49 | 377.2 | 906.8 | 1.34 | 0.32 | 1.00 | 1.91 | 0.10 | 0.10 | 0.00 | 0.28 |
| 32 | SING | 1.00 | 200 | [illegible] | 0 | 573.0 | 227.52 | 318.0 | 874.3 | 617.7 | 214.95 | 376.9 | 909.2 | 1.43 | 0.40 | 1.01 | 2.09 | 0.11 | 0.10 | 0.00 | 0.30 |
| 33 | MULT | 1.00 | 200 | 0 | 0 | 621.0 | 215.37 | 378.1 | 909.3 | 621.0 | 215.37 | 378.1 | 909.3 | 1.33 | 0.30 | 1.01 | 1.77 | 0.00 | 0.00 | 0.00 | 0.00 |
| 34 | MULT | 1.00 | 200 | 0 | 0 | 823.9 | 630.60 | 165.5 | 1502.5 | 823.9 | 630.60 | 166.5 | 1502.5 | 3.01 | 1.99 | 1.01 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 35 | SING | 1.00 | 200 | 0 | 0 | 823.9 | 630.60 | 165.5 | 1502.5 | 957.6 | 675.77 | 254.6 | 1679.6 | 3.01 | 2.00 | 1.00 | 5.00 | 2.29 | 2.29 | 0.00 | 4.57 |
| 36 | SING | 1.00 | 200 | 0 | 0 | 823.9 | 630.60 | 165.5 | 1502.5 | 839.0 | 615.49 | 196.4 | 1502.5 | 3.01 | 2.00 | 1.00 | 5.00 | 2.29 | 2.29 | 0.00 | 4.57 |
| 37 | SING | 1.00 | 200 | 0 | 0 | 839.0 | 615.48 | 196.4 | 1502.5 | 854.2 | 600.25 | 227.0 | 1502.5 | 3.01 | 2.00 | 1.00 | 5.00 | 2.29 | 2.29 | 0.00 | 4.57 |
| 38 | MULT | 1.00 | 200 | 0 | 0 | 823.9 | 630.60 | 165.5 | 1502.5 | 957.7 | 675.77 | 257.0 | 1604.3 | 3.01 | 2.00 | 1.00 | 5.00 | 2.29 | 2.29 | 0.00 | 4.57 |
| 39 | SING | 1.00 | 200 | 0 | 0 | 854.2 | 600.25 | 227.0 | 1502.5 | 909.2 | 616.16 | 257.2 | 1566.3 | 3.01 | 2.00 | 1.00 | 5.00 | 2.29 | 2.29 | 0.00 | 4.57 |
| 40 | SING | 1.00 | 200. | 0 | 0. | 823.9 | 630.60 | 166.5 | 1502.5 | 957.0 | 677.29 | 256.3 | 1667.0 | 3.01 | 1.99 | 1.01 | 5.00 | 2.29 | 2.29 | 0.00 | 4.57 |
| 41 | MULT | 1.00 | 200 | 0 | 0 | 960.2 | 676.22 | 257.2 | 1687.0 | 960.2 | 676.22 | 257.2 | 1687.0 | 3.01 | 1.99 | 1.01 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 42 | MULT | 1.00 | 400 | 0 | 0 | 620.7 | 349.32 | 76.2 | 1149.2 | 620.7 | 349.32 | 76.2 | 1149.2 | 1.77 | 0.69 | 1.00 | 3.30 | 0.00 | 0.00 | 0.00 | 0.00 |
| 43 | SING | 1.00 | 400 | 0 | 0 | 620.7 | 349.32 | 76.2 | 1149.2 | 652.1 | 359.30 | 106.2 | 1207.7 | 2.01 | 0.91 | 1.00 | 3.90 | 0.41 | 0.45 | 0.00 | 1.68 |
| 44 | SING | 1.00 | 400 | 0 | 0 | 620.7 | 349.32 | 76.2 | 1149.2 | 673.2 | 354.13 | 136.3 | 1246.2 | 1.69 | 0.69 | 1.00 | 3.13 | 0.27 | 0.32 | 0.00 | 1.18 |
| 45 | MULT | 1.00 | 400 | 0 | 0 | 620.7 | 349.32 | 76.2 | 1149.2 | 679.2 | 364.27 | 136.0 | 1269.5 | 1.93 | 0.96 | 1.00 | 3.72 | 0.37 | 0.42 | 0.00 | 1.56 |
| 46 | SING | 1.00 | 400 | 0 | 0 | 652.1 | 350.30 | 106.2 | 1207.7 | 713.7 | 379.75 | 166.5 | 1327.7 | 2.07 | 1.02 | 1.00 | 4.27 | 0.44 | 0.51 | 0.00 | 1.91 |
| 47 | SING | 1.00 | 400 | 0 | 0 | 620.7 | 349.32 | 76.2 | 1149.2 | 682.2 | 369.75 | 136.8 | 1270.1 | 2.14 | 1.05 | 1.00 | 4.30 | 0.41 | 0.45 | 0.00 | 1.68 |
| 48 | MULT | 1.00 | 400. | 0. | 0 | 713.7 | 376.75 | 166.5 | 1327.7 | 713.7 | 379.75 | 166.5 | 1327.7 | 2.12 | 1.24 | 1.01 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 49 | MULT | 1.00 | 400 | 0 | 0 | 745.4 | 350.37 | 257.2 | 1327.7 | 745.4 | 350.37 | 257.2 | 1327.7 | 2.03 | 1.15 | 1.01 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 50 | SING | 1.00 | 400 | 0 | 0 | 745.4 | 350.37 | 257.2 | 1327.7 | 757.2 | 341.63 | 288.0 | 1327.7 | 2.14 | 1.26 | 1.00 | 5.00 | 0.67 | 0.96 | 0.00 | 3.79 |
| 51 | SING | 1.00 | 400 | 0 | 0 | 745.4 | 350.37 | 257.2 | 1327.7 | 805.5 | 369.65 | 316.5 | 1446.7 | 1.79 | 0.92 | 1.00 | 4.01 | 0.45 | 0.67 | 0.00 | 2.68 |
| 52 | SING | 1.00 | 400 | 0 | 0 | 757.2 | 341.63 | 289.0 | 1327.7 | 757.2 | 341.63 | 288.0 | 1327.7 | 2.11 | 1.22 | 1.00 | 5.00 | 0.64 | 0.93 | 0.00 | 3.67 |
| 53 | MULT | 1.00 | 400 | 0 | 0 | 745.4 | 350.37 | 257.2 | 1327.7 | 807.9 | 373.63 | 317.0 | 1449.0 | 2.08 | 1.21 | 1.00 | 4.97 | 0.63 | 0.91 | 0.00 | 3.61 |
| 54 | SING | 1.00 | 400 | 0 | 0 | 757.2 | 341.63 | 289.0 | 1327.7 | 774.0 | 330.75 | 318.0 | 1327.7 | 2.11 | 1.22 | 1.00 | 5.00 | 0.64 | 0.93 | 0.00 | 3.67 |
| 55 | SING | 1.00 | 400 | 0 | 0 | 715.4 | 350.37 | 257.2 | 1327.7 | 806.9 | 374.35 | 316.2 | 1447.9 | 2.34 | 1.40 | 1.01 | 5.00 | 0.67 | 0.96 | 0.00 | 3.79 |
| 56 | MULT | 1.00 | 400 | 0 | 0 | 809.9 | 372.91 | 319.0 | 1440.0 | 809.8 | 372.81 | 318.0 | 1449.0 | 2.29 | 1.58 | 1.01 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 57 | MULT | 1.00 | 100 | 0 | 0 | 1634.5 | 22.24 | 1585.0 | 1697.0 | 1634.5 | 22.24 | 1585.0 | 1687.0 | 2.55 | 0.35 | 2.50 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 58 | MULT | 1.00 | 100 | 0 | 0 | 1634.5 | 22.24 | 1585.0 | 1697.0 | 1640.8 | 22.38 | 1570.9 | 1690.5 | 2.00 | 0.00 | 2.00 | 2.00 | 0.30 | 0.07 | 0.29 | 0.76 |
| 59 | SING | 1.00 | 100 | 0 | 0 | 1640.8 | 22.30 | 1595.9 | 1690.5 | 1659.1 | 22.32 | 1608.5 | 1707.2 | 2.00 | 0.00 | 2.00 | 2.00 | 0.30 | 0.07 | 0.29 | 0.76 |
| 70 | SING | 1.00 | 100 | 0 | 0 | 1658.1 | 22.32 | 1609.5 | 1707.2 | 1659.1 | 22.32 | 1608.5 | 1707.2 | 2.00 | 0.00 | 2.00 | 2.00 | 0.30 | 0.07 | 0.29 | 0.76 |
| 71 | SING | 1.00 | 100 | 0 | 0 | 1658.1 | 22.32 | 1608.5 | 1707.2 | 1659.1 | 22.32 | 1608.5 | 1707.2 | 2.00 | 0.00 | 2.00 | 2.00 | 0.30 | 0.07 | 0.29 | 0.76 |
| 72 | SING | 1.00 | 100 | 0 | 0 | 1658.1 | 22.32 | 1608.5 | 1707.2 | 1671.4 | 22.33 | 1622.6 | 1720.6 | 2.00 | 0.00 | 2.00 | 2.00 | 0.30 | 0.07 | 0.29 | 0.76 |
| 73 | MULT | 1.00 | 100 | 0 | 0 | 1634.5 | 22.24 | 1585.0 | 1697.0 | 1681.5 | 22.23 | 1632.0 | 1734.0 | 3.53 | 0.21 | 3.50 | 5.00 | 1.07 | 0.50 | 1.00 | 4.57 |
| 74 | MULT | 1.00 | 100. | 0 | 0 | 1671.4 | 22.33 | 1622.6 | 1730.6 | 1684.7 | 22.43 | 1636.0 | 1734.4 | 2.00 | 0.00 | 2.00 | 2.00 | 0.30 | 0.07 | 0.29 | 0.76 |
| 75 | SING | 1.00 | 100 | 0 | 0 | 1634.5 | 22.24 | 1585.0 | 1687.0 | 1682.5 | 22.30 | 1629.8 | 1735.3 | 3.53 | 0.21 | 3.50 | 5.00 | 1.07 | 0.50 | 1.00 | 4.57 |
| 76 | MULT | 1.00 | 100 | 0 | 0 | 1685.4 | 22.40 | 1635.0 | 1735.3 | 1685.4 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 77 | MULT | 1.00 | 100 | 0 | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | [illegible] | [illegible] | 0.0 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 78 | MULT | 1.00 | [illegible] | [illegible] | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | [illegible] | [illegible] | 0.0 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 79 | MULT | [illegible] | 100 | 0 | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 31.1 | 0.75 | 28.7 | 32.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 80 | MULT | [illegible] | 107 | 7 | 0 | 31.0 | 0.25 | 28.[illegible] | 32.5 | 31.0 | 0.25 | 28.9 | 32.6 | [illegible] | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.00 |

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Figure 3-22 Task Summary

(b) Detailed Output of Benchmark Iteration. Benchmark iterations (Figure 3-23) do not take operator characteristics into account during the calculations; thus, no stress values are produced. The data put forth are task number, type and essentiality, start and expected end time, regular probability, and modified probability. An asterisk in the appropriate column shows the operator(s) assigned to that task.

(c) Benchmark Iteration Results. These results (Figure 3-24) show the time remaining statistics for each operator as each assigned task is performed. SAINT applies the operator characteristics to these statistics in performing the detailed run iterations. Every operator performed task (i.e., not equipment tasks) must be performed in the benchmark iteration, or else, due to SAINT's structure, the detailed iterations will not be performed.

3.3.6.5.2 Run Iterations. The run iteration output is in four sections:

(a) Detailed Iteration Output. This output (see Figure 3-20) is in the same form as the benchmark iterations. The difference lies in the fact that operator characteristics are considered in the detailed iterations; thus, stress values on the operators are given.

(b) Summary of Iteration. This summary (see Figure 3-21) is given after each iteration. It provides information on each operator's performance times (idle time, busy time, time available, total time) and stress for that iteration.

(c) Task Summary Report. This report (see Figure 3-22) gives the following statistics on each task:

(1) Mean, minimum, maximum times and standard deviations on the time the task is realized and the time the task is completed.

(2) Task stress (Cohesiveness is also presented, but this value was never used in this study. Cohesiveness represents the amount of cooperation between operators. Because all operators are segments of one human being, this parameter cannot be applied meaningfully).

(3) Number of task releases, failures and skips.

(d) Mission Summary Report. This report (see Figure 3-25) gives the times consumed by the operators broken down according to busy, idle, and total times. The stresses felt by the operators during the mission are also presented here. The final output of this report contains the number of successful and unsuccessful missions performed.

DETAILED OUTPUT OF BENCHMARK ITERATION NUMBER 1

| TASK UMBER | TASK TYPE | TASK CSS | START TIME | EXPECTED END TIME | REC PROB | MOD PROB | COHES | TASK STRESS | OPERATOR STRESS VALUES 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 | MULT | 1.0 | 0.00 | 0.00 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 78 | MULT | 1.0 | 0.00 | 0.00 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 79 | MULT | 1.0 | 0.00 | 0.00 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 80 | MULT | 1.0 | 0.00 | 0.00 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 81 | MULT | 1.0 | 0.00 | 0.00 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 82 | MULT | 1.0 | 0.00 | 420.46 | 1.000 | 1.000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 83 | MULT | 1.0 | 0.00 | 0.00 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 84 | MULT | 1.0 | 0.00 | 0.00 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 85 | MULT | 1.0 | 0.00 | 0.00 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 86 | MULT | 1.0 | 0.00 | 0.00 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 88 | MULT | 1.0 | 420.45 | 420.46 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1 | MULT | 1.0 | 420.46 | 423.02 | 0.950 | 0.950 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 111 | MULT | 1.0 | 423.02 | 423.02 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 112 | MULT | 1.0 | 423.02 | 433.30 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 113 | MULT | 1.0 | 433.30 | 442.33 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 114 | MULT | 1.0 | 442.33 | 455.14 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 115 | MULT | 1.0 | 455.14 | 455.14 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 116 | MULT | 1.0 | 455.14 | 455.14 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | MULT | 1.0 | 455.14 | 461.21 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

****PARAMETER SET 213 REPLACED BY PARAMETER SET 78 AT TIME 461.21****

****PARAMETER SET 219 REPLACED BY PARAMETER SET 86 AT TIME 461.21****

| TASK UMBER | TASK TYPE | TASK CSS | START TIME | EXPECTED END TIME | REC PROB | MOD PROB | COHES | TASK STRESS | OPERATOR STRESS VALUES 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 | MULT | 1.0 | 461.21 | 461.21 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 78 | MULT | 1.0 | 461.21 | 461.21 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 79 | MULT | 1.0 | 461.21 | 485.33 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 80 | MULT | 1.0 | 485.33 | 485.33 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 8. | MULT | 1.0 | 485.33 | 485.33 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 82 | MULT | 1.0 | 485.33 | 906.36 | 1.000 | 1.000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 83 | MULT | 1.0 | 485.33 | 485.33 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 84 | MULT | 1.0 | 485.33 | 485.33 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 85 | MULT | 1.0 | 485.33 | 495.33 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 86 | MULT | 1.0 | 485.33 | 508.57 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 88 | MULT | 1.0 | 706.36 | 905.36 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 95 | MULT | 1.0 | 906.36 | 906.36 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 96 | MULT | 1.0 | 906.36 | 965.87 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 97 | MULT | 1.0 | 965.89 | 965.87 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | 0.00 | 0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 99 | MULT | 1.0 | 965.89 | 1085.12 | 1.000 | 1.000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 98 | SING | 1.0 | 965.89 | 1086.84 | 1.000 | 1.000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 100 | MULT | 1.0 | 965.89 | 965.89 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 101 | MULT | 1.0 | 965.89 | 990.39 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | 0.00 | 0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 102 | MULT | 1.0 | 1085.84 | 1111.14 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | MULT | 1.0 | 1111.14 | 1130.29 | 0.950 | 0.950 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 57 | MULT | 1.0 | 1130.29 | 1130.29 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 64 | MULT | 1.0 | 1130.29 | 1530.63 | 1.000 | 1.000 | 0.00 | 0.00 | 0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 58 | SING | 1.0 | 1130.29 | 1160.50 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 61 | SING | 1.0 | 1130.29 | 1730.32 | 1.000 | 1.000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 65 | SING | 1.0 | 1130.29 | 1729.68 | 1.000 | 1.000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 59 | SING | 1.0 | 1160.50 | 1183.97 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 60 | SING | 1.0 | 1183.97 | 1203.12 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 62 | SING | 1.0 | 1208.12 | 1328.29 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 63 | SING | 1.0 | 1328.29 | 1447.68 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 66 | MULT | 1.0 | 1730.32 | 1730.32 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 42 | MULT | 1.0 | 1730.32 | 1751.90 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | [illegible] | [illegible] | *0.00 | [illegible] | [illegible] | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 45 | MULT | 1.0 | 1754.90 | 1778.00 | 1.000 | 1.000 | 0.00 | 0.00 | 0.00 | [illegible] | [illegible] | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 43 | SING | 1.0 | 1754.90 | 1814.84 | 1.000 | 1.000 | 0.00 | 0.00 | *0.00 | [illegible] | [illegible] | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 44 | SING | 1.0 | 1754.90 | 1780.27 | 1.000 | 1.000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | *0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Figure 3-23 Benchmark Iterations

BENCHMARK ITERATION RESULTS

| NODE | OP | ESSENTIAL TIME REMAINING MEAN | STD. DEV. | NO. OBS. | MIN | MAX. | NON-ESSENTIAL TIME REMAINING MEAN | STD DEV. | NO OBS. | MIN | MAX. | WAITING TIME REMAINING MEAN | STD. DEV. | NO. OBS. | MIN. | MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1728 87 | 18.58 | 100.00 | 1676 72 | 1770.59 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 439.53 | 1 91 | 100.00 | 435.53 | 445.08 |
| 1 | 2 | 1602.67 | 19.08 | 100.00 | 1554.43 | 1649.34 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 753.45 | 1.69 | 100.00 | 749.46 | 757.33 |
| 1 | 3 | 1602 67 | 19 08 | 100.00 | 1554.43 | 1649 34 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 753.45 | 1.69 | 100.00 | 749.46 | 757.33 |
| 1 | 4 | 2914.42 | 18.94 | 100.00 | 2762.46 | 2859.96 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 97.72 | 1.30 | 100.00 | 95.34 | 101.83 |
| 2 | 1 | 1675 03 | 13 69 | 100.00 | 1643 18 | 1729.84 | 0 00 | 0 00 | 100 00 | 0.00 | 0.00 | 439.53 | 1.91 | 100.00 | 435.53 | 445.08 |
| 2 | 2 | 1548 82 | 14 10 | 100 00 | 1519.95 | 1598.80 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 753.45 | 1.69 | 100.00 | 749.46 | 757.33 |
| 2 | 3 | 1548 82 | 14 10 | 100.00 | 1519.95 | 1598.80 | 0.00 | 0.00 | 100 00 | 0.00 | 0.00 | 753.45 | 1.69 | 100.00 | 749.46 | 757.33 |
| 2 | 4 | 2760.58 | 13.80 | 100.00 | 2728 92 | 2814.25 | 0.00 | 0 00 | 100.00 | 0.00 | 0.00 | 97 72 | 1.30 | 100.00 | 95.34 | 101.83 |
| 3 | 1 | 1504 72 | 12 61 | 100 00 | 1470.71 | 1563.96 | 0.00 | 0.00 | 100.00 | 0 00 | 0.00 | 342 92 | 1.58 | 100.00 | 338.62 | 346.56 |
| 3 | 2 | 1402 35 | 12 82 | 100.00 | 1372.38 | 1458 29 | 0.00 | 0 00 | 100 00 | 0.00 | 0.00 | 633 01 | 1.47 | 100.00 | 629.21 | 636.67 |
| 3 | 3 | 1402 35 | 12 82 | 100.00 | 1372 38 | 1458.29 | 0.00 | 0.00 | 100.00 | 0 00 | 0.00 | 633.01 | 1.47 | 100.00 | 629.21 | 636.67 |
| 3 | 4 | 2590 27 | 12 59 | 100.00 | 2556 46 | 2648.28 | 0.00 | 0.00 | 100 00 | 0.00 | 0.00 | 1 11 | 0.93 | 100.00 | 0.00 | 4.19 |
| 4 | 1 | 1004 25 | 10 00 | 100.00 | 971.62 | 1031.43 | 0.00 | 0.00 | 100.00 | 0 00 | 0.00 | 0.56 | 0.61 | 100.00 | 0.00 | 2.23 |
| 4 | 2 | 915 91 | 10 23 | 100.00 | 886.02 | 942 64 | 0 00 | 0.00 | 100.00 | 0.00 | 0 00 | 276 62 | 1.02 | 100.00 | 273 92 | 279.78 |
| 4 | 3 | 915 91 | 10 23 | 100.00 | 886 02 | 942 64 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 276.62 | 1.02 | 100.00 | 273.92 | 279.78 |
| 4 | 4 | 1747 90 | 10 10 | 100.00 | 1715.98 | 1775.43 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 0.65 | 0.71 | 100.00 | 0.00 | 2.51 |
| 5 | 1 | 458 35 | 6.74 | 100.00 | 444.22 | 478.55 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 0 56 | 0.61 | 100.00 | 0.00 | 2 23 |
| 5 | 2 | 85 32 | 6 98 | 100.00 | 72 17 | 108 63 | 0.00 | 0.00 | 100.00 | 0 00 | 0.00 | 276.62 | 1.03 | 100.00 | 273 92 | 279.78 |
| 5 | 3 | 85 32 | 6.98 | 100.00 | 72 17 | 108.63 | 0.00 | 0 00 | 100.00 | 0.00 | 0.00 | 276.62 | 1.03 | 100.00 | 273.92 | 279.78 |
| 5 | 4 | 518 27 | 6 85 | 100.00 | 504 07 | 538 83 | 0.00 | 0 00 | 100.00 | 0 00 | 0 00 | 0 65 | 0.71 | 100.00 | 0.00 | 2.51 |
| 6 | 1 | 671.60 | 8 39 | 100.00 | 654 07 | 693.83 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 0.56 | 0.61 | 100.00 | 0.00 | 2.23 |
| 6 | 2 | 501.45 | 8 64 | 100 00 | 483 81 | 525.26 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 276.62 | 1.02 | 100.00 | 273.92 | 279.78 |
| 6 | 3 | 501 45 | 8 64 | 100.00 | 483 81 | 525.26 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 276.62 | 1.02 | 100.00 | 273.92 | 279 78 |
| 6 | 4 | 1133 38 | 8 27 | 100.00 | 1115.25 | 1155.33 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 0 65 | 0.71 | 100.00 | 0.00 | 2.51 |
| 42 | 1 | 1172 37 | 10.14 | 100 00 | 1139 25 | 1199.17 | 0.00 | 0 00 | 100 00 | 0 00 | 0 00 | 60 48 | 0.75 | 100.00 | 59 02 | 62.58 |
| 42 | 2 | 988.03 | 10.44 | 100.00 | 957 59 | 1013.99 | 0.00 | 0.00 | 100.00 | 0.00 | 0 00 | 432.54 | 1.34 | 100.00 | 428.71 | 435.32 |
| 42 | 3 | 988 03 | 10.44 | 100 00 | 957 59 | 1013 99 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 432 54 | 1.34 | 100.00 | 428.71 | 435.32 |
| 42 | 4 | 1975.94 | 10.23 | 100.00 | 1943.83 | 2002.87 | [illegible] | 0.00 | 100.00 | 0.00 | 0.00 | 0.65 | 0.71 | 100.00 | 0.00 | 2.51 |
| 42 | 5 | 1596 18 | 1 93 | 100.00 | 1591 44 | 1600 37 | [illegible] | 0 00 | 100.00 | 0.00 | 0.00 | 180 35 | 1.32 | 100 00 | 176.63 | 183.31 |
| 42 | 6 | 48 08 | 0 94 | 100 00 | 46 15 | 50 30 | 0.00 | 0 00 | 100 00 | 0.00 | 0.00 | 504.53 | 0.94 | 100.00 | 501.68 | 506.65 |
| 42 | 7 | 48.08 | 0 94 | 100.00 | 46.15 | 50.30 | 0.00 | 0 00 | 100.00 | 0.00 | 0 00 | 504.53 | 0.94 | 100.00 | 501.68 | 506.65 |
| 43 | 1 | 1148.24 | 10 08 | 100 00 | 1115 92 | 1175.46 | 0 00 | 0.00 | 100.00 | 0 00 | 0.00 | 60 48 | 0 75 | 100.00 | 59.02 | 62.58 |
| 44 | 5 | 1572 05 | 1 11 | 100.00 | 1568 01 | 1575.69 | 0.00 | 0.00 | 100 00 | 0 00 | 0 00 | 180 35 | 1 32 | 100.00 | 176.63 | 183.31 |
| 45 | 2 | 963 89 | 10 39 | 100 00 | 934.11 | 990 27 | 0.00 | 0.00 | 100.00 | 0 00 | 0 00 | 432 54 | 1.35 | 100 00 | 428.71 | 435.32 |
| 45 | 3 | 963 89 | 10 39 | 100 00 | 934 11 | 990 27 | 0 00 | 0.00 | 100 00 | 0.00 | 0 00 | 432 54 | 1.35 | 100.00 | 428.71 | 435.32 |
| 46 | 1 | 1088 17 | 10 04 | 100 00 | 1055 81 | 1115 00 | 0.00 | 0.00 | 100 00 | 0 00 | 0 00 | 60 48 | 0.75 | 100.00 | 59.02 | 62.58 |
| 47 | 4 | 1951 81 | 10.17 | 100 00 | 1920.50 | 1979.16 | 0 00 | 0.00 | 100.00 | 0.00 | 0 00 | 0.65 | 0.71 | 100.00 | 0.00 | 2.51 |
| 48 | 1 | 1028.18 | 10.05 | 100.00 | 996 16 | 1054.96 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 0.56 | 0.61 | 100.00 | 0.00 | 2.23 |
| 48 | 2 | 939 83 | 10 28 | 100 00 | 909 39 | 966 17 | 0 00 | 0 00 | 100.00 | 0 00 | 0 00 | 276 62 | 1.01 | 100 00 | 273.93 | 279 78 |
| 48 | 3 | 939 83 | 10 28 | 100 00 | 909 39 | 966.17 | 0.00 | 0 00 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 100 00 | 273.93 | 279 78 |
| 48 | 4 | 1771 83 | 10 20 | 100 00 | 1740 53 | 1798.96 | 0 00 | 0 00 | [illegible] | [illegible] | 0 00 | 0 65 | 0.71 | 100 00 | 0.00 | 2.51 |
| 48 | 5 | 1547 93 | 1 58 | 100.00 | 1544 35 | 1552.24 | 0 00 | 0 00 | [illegible] | [illegible] | 0 00 | [illegible] | 1.07 | 100.00 | 22.26 | 27 62 |
| 48 | 6 | 23.94 | 0 77 | 100 00 | 21 81 | 25.85 | 0.00 | 0 00 | 100 00 | 0 00 | 0 00 | 324 55 | 1.06 | 100 00 | 321 98 | 326.77 |



Figure 3-24 Benchmark Iteration Results

MISSION SUMMARY REPORT

| PERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD | BUSY TIME MIN | BUSY TIME MAX. | IDLE TIME MEAN | IDLE TIME STD | IDLE TIME MIN. | IDLE TIME MAX | TOTAL TIME USED MEAN | TOTAL TIME USED STD | TOTAL TIME USED MIN | TOTAL TIME USED MAX. | STRESS MEAN | STRESS STD. | STRESS MIN | STRESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3400.00 | 1420.2 | 97.0 | 1321.6 | 1812.8 | 1971.1 | 91.1 | 1656.6 | 1987.6 | 3391.3 | 104.9 | 2989.2 | 3798.1 | 1.21 | 0.05 | 1.03 | 1.39 |
| 2 | 3400.00 | 1190.4 | 19.5 | 1118.0 | 1237.8 | 2200.9 | 90.0 | 1970.3 | 2564.9 | 3391.3 | 104.9 | 2989.2 | 3798.1 | 1.11 | 0.02 | 1.01 | 1.13 |
| 3 | 3400.00 | 1190.4 | 19.5 | 1118.0 | 1237.8 | 2200.9 | 90.0 | 1870.3 | 2564.9 | 3391.3 | 104.9 | 2989.2 | 3798.1 | 1.11 | 0.02 | 1.01 | 1.13 |
| 4 | 3400.00 | 2513.9 | 106.2 | 2096.7 | 2919.7 | 977.4 | 3.2 | 870.9 | 891.6 | 3391.3 | 104.9 | 2989.2 | 3798.1 | 1.61 | 0.06 | 1.29 | 1.79 |
| 5 | 3400.00 | 2467.0 | 151.9 | 2392.6 | 3051.1 | 924.3 | 79.1 | 498.6 | 998.6 | 3391.3 | 104.9 | 2989.2 | 3798.1 | 1.44 | 0.05 | 1.19 | 1.61 |
| 6 | 3400.00 | 976.5 | 4.6 | 951.6 | 985.8 | 2414.8 | 103.4 | 2036.6 | 2818.0 | 3391.3 | 104.9 | 2989.2 | 3798.1 | 1.00 | 0.00 | 1.00 | 1.00 |
| 7 | 3400.00 | 976.5 | 4.6 | 951.6 | 985.8 | 2414.8 | 103.4 | 2036.6 | 2818.0 | 3391.3 | 104.9 | 2989.2 | 3798.1 | 1.00 | 0.00 | 1.00 | 1.00 |

77 SUCCESSFUL MISSIONS

23 UNSUCCESSFUL MISSIONS

Figure 3-25 Mission Summary Report

3.3.6.6 User Considerations. Descriptive terms have been put into the model and the evaluative terms have been supplied by SAINT. The evaluative terms must now be analyzed.

The first section of the output is an echo check of the data (paragraph 3.3.6.5) and requires no interpretation. It is merely a representation of the data that have been input. Although there is no need for interpretation, these data should be checked to ensure that the descriptive terms which have been supplied are actually those which were desired.

The detailed output of benchmark iteration is open to interpretation by the user/evaluator. All through this interpretation it must be kept in mind that the benchmarks do not take any of the operator characteristics into account. The benchmarks supply the start time of each task, the expected end time and the modified probability. Any other data presented are merely a representation of the task descriptors input. The expected end time is calculated from the parameter set and the distribution type which describes the task. The start time of a task is dictated by the sequence of the tasks and the end time of the predecessor task.

The format for the result presentation of the detailed iteration is identical to that of the benchmark iterations. In the detailed iteration, however, the operator characteristics have an effect on the results. The results set forth in the detailed iterations and affected by the operator characteristics are as follows:

(a) Task Start Time. The time, estimated in the benchmark iterations, at which the operator(s) assigned to the task will have finished the preceding task and can key in the new task.

(b) Task End Time. The time at which the task is expected to be completed. This depends on the time at which the task was started, and the expected duration of the task. The duration of the task is, in turn, dependent upon the values contained in the parameter set and the distribution type chosen.

(c) Operator Stress. A time pressure imposed on an operator by a discrepancy between the amount of work to be done and the time remaining for doing it. Prior to the start of a task, the status of each operator assigned to the task is assessed by SAINT. The time which the task will consume is subtracted from the time available, and the change in the stress of the operator caused by this task is calculated.

(d) Task Stress. The cumulative effect of the operators assigned to a task upon each other. One operator under great stress will increase the stress upon the other operators assigned to the same task.

3.3.6.6 User Considerations (Cont'd)

The iteration summary provides information on each operator's performance time in terms of available, busy, idle and used times. The stress statistics set forth are the mean stress, standard deviation, minimum and maximum stresses and the tasks in which the extreme stress values occurred. These two sets of statistics (detailed iteration, iteration summary) are the main body of data from which evaluations may be made.

The interpretation of the stress values is the most important step in an evaluation. Siegel and Wolf[2] portray any stress value up to and including the operator's stress threshold as an organizing influence which causes a decrease in the mean time of task completion, and an increase in the probability of the success of the task. Alternatively, a stress on the operator which is beyond the threshold causes a disorganizing effect (i.e., the mean task completion time increases and the probability of successfully completing the task decreases). Thus, when an evaluator discovers that the implementation of a particular device on an existing IOS lowers the average stress on the operators, it is clear that the device is beneficial. Correspondingly, if the evaluator finds that the design evaluation shows the operators' stress values to exceed their stress thresholds, the design should be altered.

The next useful output is the Task Summary Report which contains five groups of statistics (see also Figure 3-27):

(e) Counters

(f) Time task released

(g) Time task completed

(h) Task stress

(i) Task cohesiveness.

The counters group contains the number of times each task was released, skipped or failed. The other groups contain the mean, standard deviation, minimum and maximum values for the times, stress and cohesiveness.

The Mission Summary Report allows the evaluator/user to learn exactly how much of each operator's time was used productively or idled, along with the stress values they attained throughout the mission.

The number of successful missions per one hundred is also contained in this summary.

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[2] SIEGEL, A., WOLF, J., et al. Modification of the Siegel-Wolf Operator Simulation Model for On-Line Experimentation. Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, June 1971.

The final output is a histogram of any user-designated task. If a particular task is under question, it may be designated a statistics task and the evaluator may obtain further time data from the histogram (see User's Guide, Appendix I).

The user can now run the RTP with data from several different IOSs and compare the results. If different IOS activities are used, the tasks in which those data are used can be marked for a histogram. If all the other data are kept constant in both parts of the comparison, the effect of the different device on the mission can be readily noted. The number of successful missions may differ. The different devices may cause variations in the stresses throughout the mission. The average stress may vary or remain the same from one station to another. If the average stress varies (Mission Summary Report), the comparison then becomes obvious. If the average stress does not vary however, there may be differences in the time of occurrence of the stress (detailed iteration). Times of completion of both the entire mission and any tasks in question supply the easiest method for direct comparison.

### 3.3.7 Validation of Objective Methodology

3.3.7.1 Validation of Model Behavior. A validation of the evaluation methodology was carried out in order to determine the sensitivity of the model to the data which will be used on IOS design analysis.

In order to examine the model's sensitivity to changes in interface methods, the keyboard TAM was run twice, differing the active and dormant tasks each time. The first time the keyboard TAM was run, the tasks were marked active in a manner which indicates that the instructor checks the page called up on the CRT before pressing the insert button. This is shown in Figure 3-26 under the checklist column EFFECT SIM. In the second run it was assumed that the display being called would not directly affect the simulation (i.e., an assessment task), and the instructor would not check the entry before keying INSERT. The tasks checked active or dormant are in the NO EFFECT column on Figure 3-26.

The parameters resulting from the keyboard (EFFECT SIM) TAM were then assigned to each keyboard task in leg 4 of the RTP. The operators were assigned average characteristics and an estimated feasible time for completion of the mission. This will be referred to as the standard mission throughout the remainder of this report.

Next, the parameters resulting from the keyboard (NO EFFECT) TAM replaced the previous keyboard tasks while all other parameters remained the same.

The standard mission was run again, this time to determine the effect of changing the speed factor of the operators. In another run of the standard mission, the stress thresholds of the operators were set below average (i.e., less than 2.5).

## KEYBOARD TAM 18

| | | Effect. Sim. | | No Effect | |
|---|---|---|---|---|---|
| | | A | D | A | D |
| 1 | Attention-Getter | | ✓ | | ✓ |
| 10 | Visually Access Display | ✓ | | ✓ | |
| 40 | IPTASK | ✓ | | ✓ | |
| 50 | Information Type I | | ✓ | | ✓ |
| 51 | II | ✓ | | ✓ | |
| 52 | III | | ✓ | | ✓ |
| 53 | IV | | ✓ | | ✓ |
| 60 | Read (Type I) Display | | ✓ | | ✓ |
| 61 | II | | ✓ | | ✓ |
| 62 | III | ✓ | | ✓ | |
| 63 | IV | | ✓ | | ✓ |
| 80 | Decide to Change Display | ✓ | | ✓ | |
| 11 | Visually Access Keyboard | ✓ | | ✓ | |
| 20 | Manually Access Keyboard | ✓ | | ✓ | |
| 30 | Key In (Param. Set Choice) | ✓ | | ✓ | |
| 10 | Visually Access Display | ✓ | | | ✓ |
| 40 | IPTASK | ✓ | | | ✓ |
| 50 | Information Type I | | ✓ | | ✓ |
| 51 | II | ✓ | | | ✓ |
| 52 | III | | ✓ | | ✓ |
| 53 | IV | | ✓ | | ✓ |
| 70 | Display Delay | ✓ | | ✓ | |
| 60 | Read (Type I) Display | | ✓ | | ✓ |
| 61 | II | | ✓ | | ✓ |
| 62 | III | ✓ | | | ✓ |
| 63 | IV | | ✓ | | ✓ |
| 81 | Verify Change has been implemented correctly | ✓ | | | ✓ |
| 12 | Visually Access Keyboard | ✓ | | | ✓ |
| 21 | Manually Access Keyboard | ✓ | | ✓ | |
| 31 | Key INSERT (P.S.) | ✓ | | ✓ | |

Figure 3-26 Keyboard TAM Effect/No Effect

3.3.7.1 Validation of Model Behavior (Cont'd)

The final perturbation to the standard mission data was the allowance of excess time for the completion of the mission. The results of these data changes are as follows.

Keyboard TAM (EFFECT SIM) had tasks 1, 50, 52, 53, 54, 60, 61, 63 marked dormant. Keyboard TAM (NO EFFECT) had tasks 1, 50, 52, 53, 60, 61, 63 and 12 set dormant initially. Using SAINT's parameter modification capabilities, the completion of task 80 was specified to cause tasks 10, 40, 51 and 62 to be made dormant in the NO EFFECT TAM (these tasks are used to check the display before it is inserted). The rest of the data were identical for both TAMs. The results of the TAMs are provided in Table 3-1.

Table 3-1

| | TIME OF COMPLETION (IN SECONDS) | | | | NUMBER OF SUCCESSFUL MISSIONS |
|---|---|---|---|---|---|
| | Mean | Min. | Max. | Std. | |
| Effects Sim: | 13.4 | 0.0 | 67.0 | 6.42 | 95/100 |
| No Effect: | 8.1 | 0.0 | 14.9 | 2.53 | 100/100 |

The data supplied by the keyboard (EFFECT SIM) TAM were inserted into RTP leg 4 (i.e., the keyboard tasks in the RTP were assigned parameter sets with values of 13.4, 0.0, 67.0 and 6.42 seconds). These parameter sets were assigned to tasks 1 to 6, 87, 92, 112 to 114. The results of 100 iterations with these data are found in Table 3-2.

Table 3-2

| TIME OF COMPLETION (IN SECONDS) | | | | NUMBER OF SUCCESSFUL MISSIONS |
|---|---|---|---|---|
| Mean | Min. | Max. | Std. | |
| 3401.4 | 2999.4 | 3811.3 | 105.60 | 77/100 |

The data from the keyboard (NO EFFECT) TAM were then substituted for the keyboard (EFFECT SIM) TAM data. Thus, the parameter sets describing tasks 1 to 6, 87, 92, 112 to 114 now have values (in seconds) of 8.1/mean, 0.0/minimum, 14.9/maximum and a standard deviation of 2.53. The remainder of the data is identical to the standard mission. The results of 100 iterations of these data are provided in Table 3-3.

3.3.7.1 Validation of Model Behavior (Cont'd)

Table 3-3

| TIME OF COMPLETION (IN SECONDS) | | | | NUMBER OF SUCCESSFUL MISSIONS |
|---|---|---|---|---|
| Mean | Min. | Max. | Std. | |
| 3274.0 | 2997.6 | 3374.8 | 152.31 | 100/100 |

The next perturbation in the standard mission data was an increase in the operator speed factor. The value of the speed factor was decreased from 1.0 to 0.8. Thus the time taken for these operators to perform a task is decreased by a factor of 0.2. The remainder of the data is identical to the standard mission. The results of 100 iterations of these data are found in Table 3-4.

Table 3-4

| TIME OF COMPLETION (IN SECONDS) | | | | NUMBER OF SUCCESSFUL MISSIONS |
|---|---|---|---|---|
| Mean | Min. | Max. | Std. | |
| 2695.4 | 2658.7 | 2729.0 | 14.78 | 100/100 |

The values for the operator stress thresholds were changed next. The previously used value of 2.5 was changed to 1.9. The remainder of the data is identical to the standard mission. The results of 100 iterations of these data are in Table 3-5.

Table 3-5

| TIME OF COMPLETION (IN SECONDS) | | | | NUMBER OF SUCCESSFUL MISSIONS |
|---|---|---|---|---|
| Mean | Min. | Max. | Std. | |
| 4567.3 | 4124.8 | 4749.6 | 146.91 | 0/100 |

The final data perturbation in the validation study was change in the time allotted to each operator for the completion of the mission. The time allotted (3400.00 seconds) was increased to 4000.00 seconds. The rest of the data remained identical to the standard mission. The results are in Table 3-6.

Table 3-6

| TIME OF COMPLETION (IN SECONDS) | | | | NUMBER OF SUCCESSFUL MISSIONS |
|---|---|---|---|---|
| Mean | Min. | Max. | Std. | |
| 3166.6 | 3133.7 | 3215.4 | 14.41 | 100/100 |

Discussion and interpretation of these results is presented in paragraph 3.3.7.1.1.

3.3.7.1.1 Analysis of Results. The Task Summary Report and the Mission Summary Report have provided data required to analyze the results of perturbations of data (paragraph 3.3.7.1). As can be seen from Table 3-1, the keyboard TAM, which was used when there would be no effect on the simulation, consumed an average of 5.3 seconds less than the keyboard which would affect the simulation. This was an expected result because parameter changes caused four tasks in the NO EFFECT TAM to become dormant (i.e., use zero time).

The task which logically followed (in view of the static and dynamic evaluations) was the insertion of these TAMs into a leg of the RTP. Leg 4 was arbitrarily chosen. When the values for the EFFECT SIM keyboard TAM (Table 3-1) were used for each keyboard task in leg 4 of the RTP, the values in Table 3-2 resulted. A comparison of the values of Table 3-2 and Table 3-3 (NO EFFECT) showed that the NO EFFECT TAM used 127.4 fewer seconds from the total mission time than did the EFFECT SIM keyboard TAM. Table 3-7 shows that the NO EFFECT TAM caused 8.3% less stress on operator 4. These results were further enforced by the fact that the RTP containing the NO EFFECT TAM was 100% successful, while the RTP with the EFFECTS SIM TAM was only 77% successful. In this respect, the model proved itself to be extremely sensitive to the type of data perturbations which the evaluation of implementing different interfacing techniques would cause, thus establishing itself as an effective design evaluating tool.

Table 3-7

| | AVERAGE OPERATOR STRESS (OP#4) | MEAN MISSION TIME | SUCCESSFUL MISSIONS PERIOD |
|---|---|---|---|
| RTP-EFFECT SIM KEYBOARD TAM (STANDARD MISSION) | 1.61 | 3401.4 | 77 |
| RTP-NO EFFECT KEYBOARD TAM | 1.47 | 3274.0 | 100 |
| INCREASE OPERATOR SPEED | 1.07 | 2695.4 | 100 |
| DECREASE STRESS THRESHOLD | 2.37 | 4567.3 | 0 |
| EXCESS TIME | 1.12 | 3166.6 | 100 |

The change (by 0.2) of the operator speed decreased the mean stress value on operator 4 by 0.54. The mission time decreased by 706.0 seconds. Also, the maximum stress moved from task 48 to task 57.

The lowering of the stress threshold caused an increase (0.76) in the stress on operator 4. Due to the disorganizing effect of the high stresses, this mission exceeded the standard mission by 1165.9 seconds. The maximum stress tasks moved from task 57 to 66.

The allowance of more time for the mission caused a decrease of 0.48 in the stress value of operator 4. Because the operators were not frequently under a stress greater than the assigned stress threshold, the stress had an organizing effect shown in the fact that the time for completion of the excess time mission is 234.8 seconds lower than that of the standard RTP.

3.3.7.1.2 Conclusions. These results validate the developed model as a usable tool for the evaluation of an IOS. The model is sensitive to perturbations of input data. This sensitivity will greatly aid a designer in evaluating an IOS concept. For evaluation purposes, the RTP with the EFFECT SIM keyboard TAM is the most beneficial. The changing of a single parameter set in only 11 tasks of the RTP changed the average stress on the operators, the number of successful missions, and the average times of completion. These results are invaluable in evaluating or choosing interface methods.

The results of the run with excess time show the effects of increasing the time allowed for a mission. This will tremendously aid an evaluator or designer, who can now choose the best interface method to fit not only stress characteristics, but also time limitations.

The runs with an increased operator speed factor and decreased stress thresholds show the effect operator characteristics have on the mission. The operator characteristics can now be taken into account in the design or evaluation of an IOS.

3.3.7.2 Validation of Model/Real World Conversions. The key to an evaluation lies in the TAMs. Although the TAMs have been treated as building blocks for the RTP, they are also independent entities capable, in themselves, of evaluating IOS interface devices.

The parameter sets needed to quantify the tasks comprising the TAMs were chosen from PARAMINDX.DAT (Appendix G). A time to perform the particular IOS activity was estimated, and this amount of time was allotted to the TAM. The TAMs were then run and their results were compared with an actual trial performed on a jet trainer IOS.

The TAM chosen to validate the "model to real world conversions" was keyboard TAM 18 (adjacent CRT).

The time data used to quantify the task within the TAM were obtained either experimentally or from ergonomic literature.

The parameters assigned to the tasks within the keyboard were as provided in Table 3-8.

3.3.7.2 Validation of Model/Real World Conversions (Cont'd)

Table 3-8

| | | Mean | Min | Max | Std. |
|---|---|---|---|---|---|
| *10 | Visually Access Display | 1.78 | 1.50 | 2.0 | 0.23 |
| *40 | IPTASK | - | - | - | - |
| 51 | Information Type II[1] | 1.00 | 0.80 | 1.10 | 0.75 |
| 62 | Read Info Type II[2] | 1.00 | 0.80 | 1.10 | 0.05 |
| *80 | Decide to Change Display | 1.00 | 0.80 | 1.20 | 0.05 |
| *11 | Visually Access Keyboard | 1.78 | 1.50 | 2.00 | 0.23 |
| *20 | Manually Access Keyboard | 1.00 | 0.80 | 1.20 | 0.32 |
| 30 | Key In[3] | 1.35 | - | - | - |
| *81 | Verify change has been implemented correctly | 1.00 | 0.80 | 1.20 | 0.05 |
| *12 | Visually Access Keyboard | 1.78 | 1.50 | 2.00 | 0.23 |
| *21 | Manually Access Keyboard | 1.00 | 0.80 | 1.20 | 0.32 |
| *70 | Display Delay | 1.00 | 0.90 | 1.10 | 0.02 |
| 31 | Key Insert[4] | 0.02 | - | - | - |

*NOTE: These parameters have been estimated.

[1] PIERCE, J., & Kailin, J. Reading Rates and the Information Rates of a Human Channel. Bell System Technical Journal, March 1957.

[2] Ibid.

[3] NEAL, A. Time Intervals between Keystrokes, Records and Fields in Data Entry with Skilled Operators. Human Factors, 1977, 12(2), 163-170.

[4] Ibid.

Keyboard TAM 18 was used to call up a CRT page. The results of running this TAM were (in seconds) 15.6/mean, 0.0/minimum, 78.3/maximum and 6.83/standard.

The minimum time of 0.0 occurred when the page to be called was already displayed on the CRT (no change was necessary). The maximum time was due to errors in key strokes which then necessitated the repetition of the TAM.

The times arrived at for experimental performance of the IOS activity were (in seconds) 12.5/mean, 9.0/minimum, 20.0/maximum, and 2.1/standard.

These results were obtained using a subject who was naive to the IOS study and having him call up a CRT page. The minimum value determined experimentally was higher than that obtained from running the TAM. The explanation is that, experimentally, the page was always called up. The possibility that the page had already been displayed was not considered. The maximum values also differ because there was no stress in the experimental conditions.

The discrepancy in the mean time between real world and model results can be explained by the parameter sets. The parameters quantifying the tasks in the TAMs were actually "best estimates." However, the model did prove its results to be realistic with the input data. Thus, as the input data describing the tasks become more refined (or realistic), the output more closely approximates real life conditions.

3.3.8 Summary. An evaluative process was developed which will accept from the user an easily generated quantitative description of a candidate interface and produce an objective assessment of the described interface. The evaluative model is objective and task-specific, developing suitability measures of an interface to an instructor activity.

Qualitative descriptors were defined quantitatively for insertions into the model. This was accomplished through four stages of development:

(a) Instructional Task List (ITL). The ITL is a compilation of all known activities an instructor may perform to set up the simulator, present and participate in a training mission, and observe the trainee's performance.

(b) Representative Task Profile (RTP). The RTP is a typical training mission assembled by sequencing selected activities as presented in the ITL.

(c) Instructor Task Description (ITD). The ITD is a further breakdown of the items of the RTP into the tasks which comprise them.

(d) IOS Activities List. This list is the final link in the descriptive chain. It links the instructive tasks of the RTP and the man-machine allocations of the ITD to the available/desirable IOS devices.

3.3.8 Summary (Cont'd)

The ITL lists the tasks an instructor may perform on an IOS. The RTP is an arrangement of some of the ITL tasks in lesson plan fashion. The ITD relates the RTP tasks to an IOS. The IOS Activity List gives interface methods (TAMs) by which the ITD items may be performed.

An evaluation is twofold: static and dynamic. The static evaluation covers the basic suitability of an IOS device to a given task. To complete the evaluation, the individual task-device combinations must be tested under realistic conditions in the context of the IOS interface as a whole.

The basic device for a static evaluation is the TAM. TAMs are written to describe each action an instructor performs to accomplish a given task with a designated interface method. TAMs are structured to contain most actions needed to perform the given task in several ways. As such, not all tasks comprising a TAM are always necessary. SAINT affords a user the opportunity to designate the necessary tasks active and the others dormant, thus always maintaining the structural integrity of the TAM. The tasks which are linked to build a TAM are:

(e) Visual access

(f) Manual access

(g) Operation

(h) Read

(i) Decision

(j) Information type

(k) Display qualifier

(l) Attention-getter.

The human instructor is divided into seven operators:

(m) Visual

(n) Right manual

(o) Left manual

(p) Cognitive

(q) Audio

(r) Verbal

(s) Pedal.

3.3.8 Summary (Cont'd)

The dynamic phase of the evaluation is performed using the RTP. The TAMs are arranged in a logical order to simulate a lesson plan. The basic construction of the RTP is similar to that of the TAMs, with the capability of active and dormant designations. The RTP is made up of modules, each of which are model descriptions of one task described in the ITD. These modules are divided into three classifications:

(t) Simulation control modules

(u) Assessment modules

(v) Documentation modules.

The tasks are mathematically described by parameter sets. The parameter set contains the mean time, maximum time, standard deviation, and minimum time for the completion of a task.

These values are fitted to one of 11 specified time distribution curves and acted upon by the operator's stress threshold, accuracy factor, and speed factor. A time is then assigned to each task. Parameter sets which are assigned to a task need not remain with that task throughout the network. Thus, if the same task is repeated, but the times taken to perform it should be different with each repetition, the network need not be interrupted or corrupted. SAINT provides the capability of having the completion of one task trigger a parameter set change.

SAINT's output is divided into benchmark and detail iterations. The benchmark iterations provide statistics on start and end times of the tasks, but do not take any of the operator characteristics (i.e., speed, stress, accuracy) into account.

The detailed iterations provide outputs on start and end times for tasks, operator stress, task stress, cohesiveness, and operator idle and busy times, plus a summary of all 100 iterations.

The system was validated by running the keyboard TAM with two different data sets. The summary statistics from keyboard TAM I, which included the instructor checking the display before pressing INSERT, were used as the parameter sets for any task in the RTP (leg 4) requiring a keyboard to call up a CRT page. The same leg of the RTP was then run with keyboard TAM II, in which the tasks pertaining to checking the display were designated dormant. The summary statistics from TAM II were then inserted into the RTP in place of these from TAM 1. As expected, less time was consumed when TAM II was used. The stresses on the operators in the RTP were also smaller as a result of the substitution of TAM II. Operator speed factor was increased and the model behaved as predicted. The time taken for the mission and the average stresses on the operators was lower. When the operator stress threshold was lowered, the model also behaved predictably, showing greater task stress and operator stress, greater disorganization and a requirement for a larger time allotment.

# 4. APPLICATION OF OBJECTIVE METHODS

## 4.1 Evaluation of Candidate Methods

4.1.1 Introduction to Detailed Research Plan. The purposes of the detailed research plan are first to apply the developed evaluation methodology to three interface techniques and second to compare two different IOS designs intended for the same simulator.

The TAM's and their analytical networks define the static physical aspects of the respective devices and provide input ports for all pertinent factors, e.g., display quality, information exchange rate and human performance parameters. The data obtained from these TAMs are inserted into the RTP which is then run as a benchmark task.

The values for the parameter sets implemented in the TAMs are obtained either through literature searches of ergonomic data or through best approximations when pertinent literature is not available (paragraph 3.3.7.2).

The capabilities of the model are demonstrated using an RTP as a typical IOS task, and implementing it to evaluate first, two IOS configurations, and subsequently, three candidate interfacing methods.

The expected results of these tests included establishment of the usefulness of the model, generation of comparative data for the candidate methods, and provision of further information useful in developing new design concepts and IOS applications.

4.1.1.1 Purpose and Scope of Plan. The purpose of the first part of the plan, comparison of two existing instructor operator stations, was to show the approach used to implement the evaluation methodology. The comparison shows how to analyze IOS configurations using data supplied by the TAMs for the RTP, and how to analyze and compare the results obtained.

The purpose of the second part of the plan, evaluation of interfacing techniques, was to demonstrate the suitability of three interface methods to the task performed on a particular IOS. Three interface methods were evaluated first, on their own merit (in TAMs) and second, as an integral part of an IOS on which a typical mission was performed.

The instructor/operator stations chosen for evaluation were two offboard configurations for a typical jet fighter trainer (Figures 4-1 and 4-2). The rationale for this selection was to show how the different configurations of an IOS controlling the same simulator and performing the same mission affect the operator's performance.

4.1.1.2 Expected Results. The research plan has been proposed to accomplish the following:

(a) To establish the validity of the modelling philosophy, structure, and mechanization of the RTP by actual test and usage.

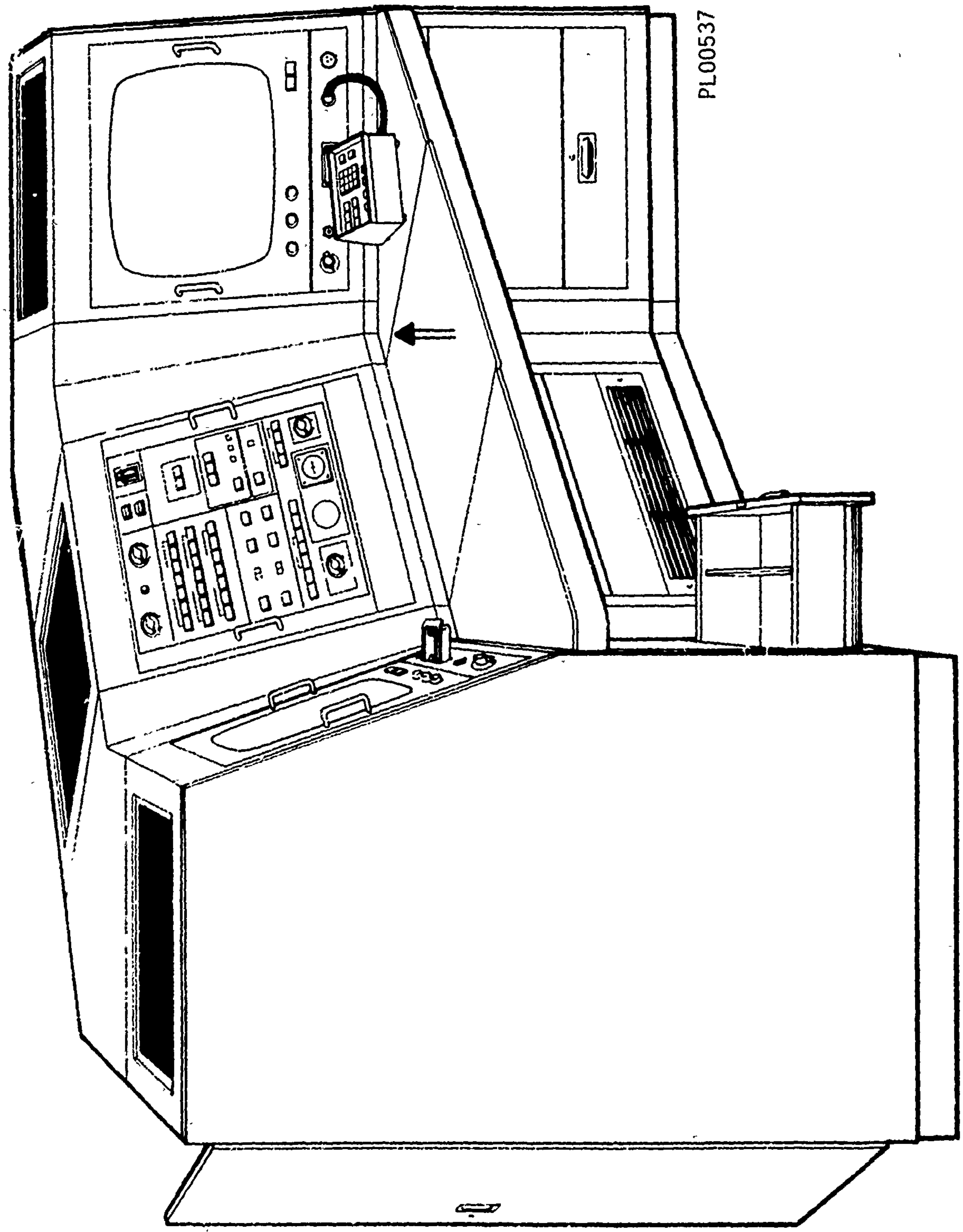


Figure 4-1 Instructor Station #1

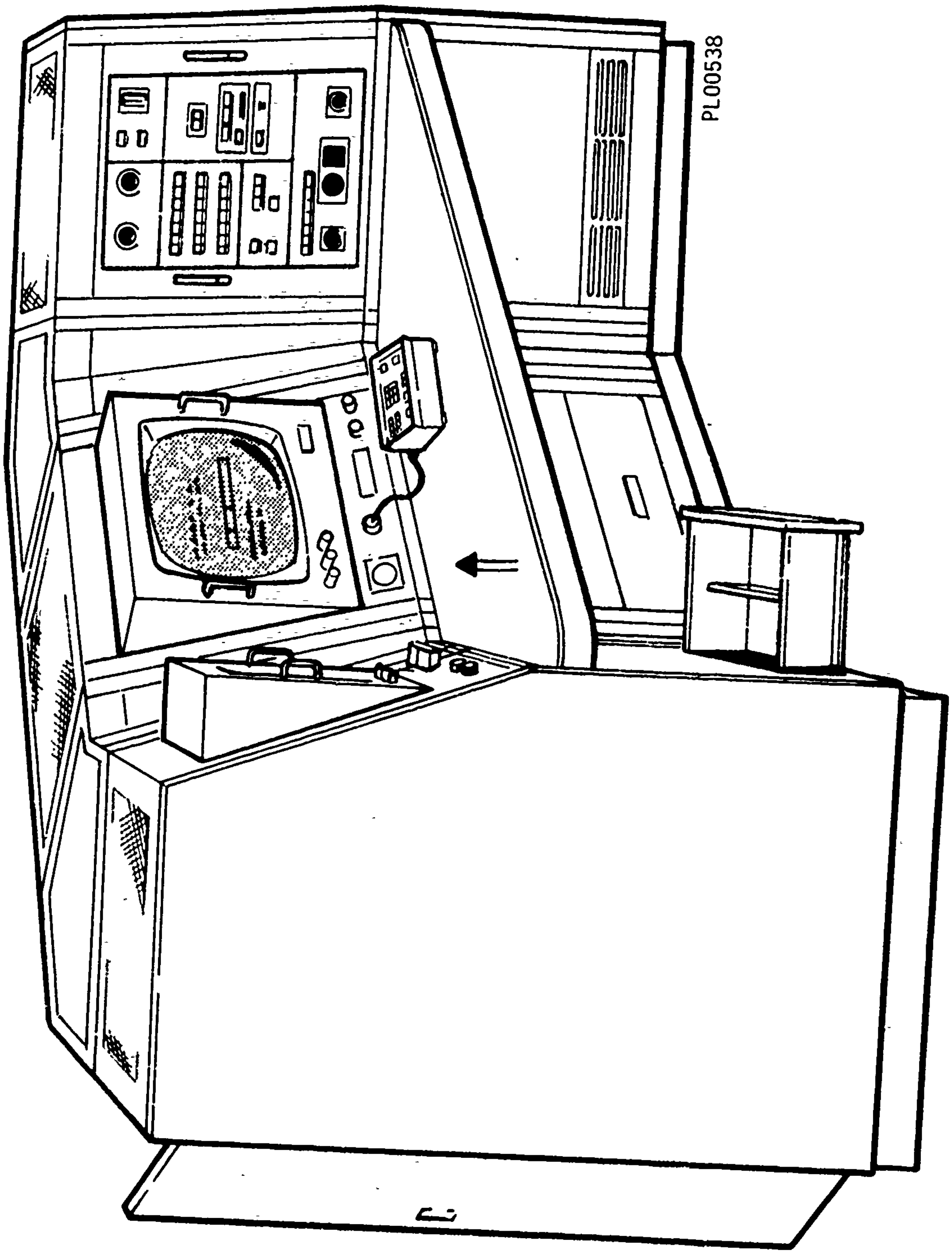


Figure 4-2 Instructor Station #2

(b) To verify the implementation method whereby the user can transform qualitative real world data into modelling parameters in a step-by-step fashion, and demonstrate the utility and ease of access to the model output data.

(c) To yield insight into the parameter sensitivity pattern in the man-IOS system by virtue of comparative performance readouts for the three candidate interface modules and two IOS configurations.

(d) To generate data upon which further development work may be based and which will support the discussion of new design concepts, as well as refinements of the modelling technique.

### 4.1.2 Comparison of Two IOS Configurations

4.1.2.1 Basic Approach. The two configurations are referred to as #1 and #2 (Figures 4-1 and 4-2). The two configurations differ only in the placement of the CRT's; the hardware on #1 is identical to that on #2. The CRT's on #1 are located at either end of the instructor console, separated by the panel. The CRT's on #2 are adjacent to each other on the left and center of the console while the panel is on the right third of the station. In each case, both CRT's are controlled by an auxiliary keyboard or dedicated push button. The arrows on the figures (4-1 and 4-2) indicate the instructor's position at the IOS.

The evaluation was performed using the RTP (Appendix B) as a lesson plan. The ITD (Appendix C), which is an expansion of the RTP, and the IOS Activities List (Appendix C), both in the general form, were tailored to fit the instructor stations in question. This tailoring was accomplished by designating IOS activities as either active or dormant. This step was necessary because the IOS Activities List, associated with each item of the ITD, was designed to allow for all possible methods in which that task could be performed. That is, not every IOS activity presented is applicable to the design of every instructor station.

TAMs describing the activities pertinent to the console were then chosen. The tasks comprising the chosen TAMs were assigned parameter sets (Appendix G) and run in SAINT. In readying these TAMs for running, several assumptions were made for the sake of consistency.

(a) Attention-getting tasks in the TAMs were always designated dormant

(b) The instructor would always check the display to ascertain that the desired change had been implemented.

The design of the jet trainer console confronted the evaluators with several constraints. These are:

(c) Stylized instruments (CRT PG 600) could be called up only to the right video display unit (RVDU)

(d) Scaling and centering of maps was a combination of keyboard and push button tasks.

Due to the fact that the two jet trainer consoles differed only in the placement of the CRT's, the IOS activities were identical for both #1 and #2 with only the visual access times, manual access times, and the cumulative effects of these times differing between the two configurations.

4.1.2.2 Test and Demonstration Results. The TAMs (and their reference code letters) in which the differences between #1 and #2 surface are:

(a) Read TAM

(1) CRT adjacent to instructor position (A)

(2) CRT remote from instructor position (B)

(b) Keyboard TAM

(1) Keyboard accessing CRT adjacent to instructor position (between 5 and 12 keystrokes) (H)

(2) Keyboard accessing CRT remote from instructor position (between 5 and 12 keystrokes) (G)

(3) Single key not accessing a display, e.g., HARD COPY (M)

(c) Push Button TAM

(1) Push button in bank accessing remote CRT (C)

(2) Unique push button accessing remote CRT (E)

(3) Push button in bank accessing adjacent CRT (D)

(4) Unique push button accessing adjacent CRT (F)

(d) Map TAM

(1) Push button panel adjacent to CRT, keyboard adjacent to CRT (I)

(2) Push button panel adjacent to CRT, keyboard remote from CRT (J)

(3) Push button panel remote from CRT, keyboard adjacent to CRT (K)

(4) Push button panel remote from CRT, keyboard remote from CRT (L)

The time parameters for the remaining tasks in the modules are identical for #1 and #2. The results of running the TAMs are shown in Appendix G. These code letters will be used to identify these parameter sets throughout this section.

4.1.2.2 Test and Demonstration Results (Cont'd)

The keyboard TAM (see Figure 3-26), both adjacent to and remote from display, assumed that the instructor checked the display to verify the change had been implemented. Tasks numbered 10, 40, 51, 62, 80, 11, 20, 30, 81, 12, 21, 70 and 31 were activated for both types of keyboard TAMs. The parameter sets differed for tasks numbered 10, 11, 12 (all visual access task). The values for locating and focusing on a CRT from an adjacent keyboard or on a keyboard from an adjacent CRT were experimentally determined to be (in seconds):

| Mean | Max. | Min. | Std. |
|---|---|---|---|
| 1.78 | 1.50 | 2.00 | 0.23 |

The same values for the remote CRT were:

| | | | |
|---|---|---|---|
| 2.40 | 2.00 | 3.00 | 0.42 |

The number of keystrokes was greater than or equal to five in both cases and the time allotted for completion of the TAMs was 17 seconds. The results of running these TAMs with the above values are shown in Figures 4-3 to 4-5.

Table 4-1 restates the parameters obtained from running these TAMs. These parameters will be used in the RTP.

Table 4-1 Restated TAM Parameters

| | Time Task Completed (in seconds) | | | | Missions | |
|---|---|---|---|---|---|---|
| | Mean | Min. | Max. | Std. | Successful | Unsuccessful |
| Adjacent | 15.7 | 0.0 | 78.4 | 7.51 | 97 | 3 |
| Remote | 16.3 | 0.0 | 40.9 | 5.24 | 75 | 25 |

As can be seen from the table, a keyboard located adjacent to the CRT being addressed requires 0.6 second less access time than a remote keyboard. Given the same amount of time to complete TAM, the IOS with the keyboard adjacent to the CRT had a 97% successful completion rate compared to 75% for the remote configuration. A successful mission is one in which all tasks are completed in the prescribed maximum time. Unsuccessful missions result from insufficient time allotments which raise stress levels, thereby degrading the operator performance.

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD | BUSY TIME MIN | BUSY TIME MAX | IDLE TIME MEAN | IDLE TIME STD | IDLE TIME MIN | IDLE TIME MAX | TOTAL TIME USED MEAN | TOTAL TIME USED STD | TOTAL TIME USED MIN | TOTAL TIME USED MAX. | STRESS MEAN | STRESS STD | STRESS MIN. | STRESS MAX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 17.[illegible] | [illegible] | [illegible] | 0.0 | [illegible] | 2.8 | 1.7 | 0.0 | 18.5 | 15.7 | 7.5 | 0.0 | 78.4 | 1.27 | 0.39 | 1.00 | 4.30 |
| 2 | 17.[illegible] | [illegible] | 1.9 | 0.0 | 17.6 | 12.4 | 5.7 | 0.0 | 60.8 | 15.7 | 7.5 | 0.0 | 78.4 | 0.60 | 0.46 | 0.00 | 4.04 |
| 3 | 17.[illegible] | 3.[illegible] | 1.9 | 0.0 | 17.6 | 12.4 | 5.7 | 0.0 | 60.8 | 15.7 | 7.5 | 0.0 | 78.4 | 0.60 | 0.46 | 0.00 | 4.04 |
| 4 | 17.[illegible] | 14.[illegible] | 7.1 | 0.0 | 73.9 | 1.3 | 0.5 | 0.0 | 4.5 | 15.7 | 7.5 | 0.0 | 78.4 | 1.29 | 0.40 | 1.00 | 4.34 |

97 SUCCESSFUL MISSIONS

3 UNSUCCESSFUL MISSIONS

Figure 4-3 Keyboard TAM Adjacent - Mission Summary

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| ASK NO | TASK TYPE | TASK ESS | COUNTERS REL | COUNTERS FAIL | COUNTERS SKIP | TIME TASK REALIZED MEAN | TIME TASK REALIZED STD. | TIME TASK REALIZED MIN. | TIME TASK REALIZED MAX. | TIME TASK COMPLETED MEAN | TIME TASK COMPLETED STD. | TIME TASK COMPLETED MIN. | TIME TASK COMPLETED MAX. | TASK STRESS MEAN | TASK STRESS STD. | TASK STRESS MIN. | TASK STRESS MAX. | TASK COHESIVENESS MEAN | TASK COHESIVENESS STD. | TASK COHESIVENESS MIN. | TASK COHESIVENESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EOMT | 1.00 | 100 | 1 | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | | | | | | | | |
| 10 | MULT | 1.00 | 195 | 0 | 0 | 5.0 | 6.83 | 0.0 | 61.7 | 6.4 | 6.79 | 1.5 | 65.7 | 1.55 | 0.71 | 1.00 | 5.00 | 0.18 | 0.64 | 0.00 | 4.57 |
| 11 | MULT | 1.00 | 95 | 0 | 0 | 5.9 | 5.89 | 4.5 | 54.1 | 7.7 | 6.12 | 6.2 | 56.9 | 1.15 | 0.73 | 1.00 | 5.00 | 0.11 | 0.66 | 0.00 | 4.57 |
| 12 | MULT | 1.00 | 72 | 0 | 0 | 13.9 | 6.57 | 12.0 | 72.7 | 15.6 | 6.83 | 13.5 | 76.6 | 1.09 | 0.59 | 1.00 | 5.00 | 0.10 | 0.67 | 0.00 | 4.57 |
| 20 | MULT | 1.00 | 76 | 0 | 0 | 7.7 | 6.12 | 6.2 | 56.9 | 8.7 | 6.30 | 7.0 | 59.0 | 1.17 | 0.80 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 21 | MULT | 1.00 | 92 | 0 | 0 | 15.6 | 6.83 | 13.5 | 76.6 | 16.6 | 6.96 | 14.5 | 78.3 | 1.09 | 0.59 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 30 | MULT | 1.00 | 76 | 0 | 0 | 8.7 | 6.30 | 7.0 | 59.0 | 10.1 | 6.53 | 8.3 | 61.7 | 1.17 | 0.80 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 31 | MULT | 1.00 | 100 | 0 | 0 | 15.6 | 7.51 | 0.0 | 78.3 | 15.7 | 7.51 | 0.0 | 78.4 | 1.12 | 0.69 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 40 | EOMT | 1.00 | 175 | 0 | 0 | 6.4 | 6.79 | 1.5 | 65.7 | 6.5 | 6.79 | 1.6 | 65.8 | | | | | | | | |
| 50 | MULT | 1.00 | 195 | 0 | 0 | 6.5 | 6.79 | 1.6 | 65.8 | 6.5 | 6.79 | 1.6 | 65.8 | 1.58 | 0.72 | 1.00 | 5.00 | 0.19 | 0.64 | 0.00 | 4.57 |
| 51 | MULT | 1.00 | 175 | 0 | 0 | 6.5 | 6.79 | 1.6 | 65.8 | 7.3 | 6.80 | 2.5 | 67.9 | 1.58 | 0.72 | 1.00 | 5.00 | 0.19 | 0.64 | 0.00 | 4.57 |
| 52 | MULT | 1.00 | 195 | 0 | 0 | 7.3 | 6.80 | 2.5 | 67.9 | 7.3 | 6.80 | 2.5 | 67.9 | 1.59 | 0.73 | 1.00 | 5.00 | 0.19 | 0.64 | 0.00 | 4.57 |
| 53 | MULT | 1.00 | 195 | 0 | 0 | 7.3 | 6.80 | 2.5 | 67.9 | 7.3 | 6.80 | 2.5 | 67.9 | 1.59 | 0.73 | 1.00 | 5.00 | 0.19 | 0.64 | 0.00 | 4.57 |
| 60 | MULT | 1.00 | 195 | 0 | 0 | 7.8 | 7.14 | 2.5 | 68.9 | 7.8 | 7.14 | 2.5 | 68.9 | 1.78 | 0.87 | 1.00 | 5.00 | 0.23 | 0.65 | 0.00 | 4.57 |
| 61 | MULT | 1.00 | 175 | 0 | 0 | 7.8 | 7.14 | 2.5 | 68.9 | 7.8 | 7.14 | 2.5 | 68.9 | 1.78 | 0.87 | 1.00 | 5.00 | 0.23 | 0.65 | 0.00 | 4.57 |
| 62 | MULT | 1.00 | 175 | 0 | 0 | 7.8 | 7.14 | 2.5 | 68.9 | 8.8 | 7.20 | 3.5 | 70.7 | 1.78 | 0.87 | 1.00 | 5.00 | 0.23 | 0.65 | 0.00 | 4.57 |
| 63 | MULT | 1.00 | 175 | 0 | 0 | 8.8 | 7.20 | 3.5 | 70.7 | 8.8 | 7.20 | 3.5 | 70.7 | 1.89 | 0.99 | 1.00 | 5.00 | 0.25 | 0.65 | 0.00 | 4.57 |
| 70 | EOMT | 1.00 | 96 | 0 | 0 | 11.9 | 7.22 | 10.0 | 67.9 | 12.9 | 7.22 | 10.9 | 68.9 | | | | | | | | |
| 80 | SING | 1.00 | 100 | 7 | 0 | 4.8 | 5.49 | 3.5 | 51.7 | 5.8 | 5.69 | 4.5 | 54.1 | 1.12 | 0.63 | 1.00 | 5.00 | 0.10 | 0.64 | 0.00 | 4.57 |
| 81 | SING | 1.00 | 96 | 4 | 0 | 13.8 | 7.44 | 11.4 | 70.7 | 14.4 | 7.70 | 12.0 | 72.7 | 1.97 | 0.66 | 1.57 | 5.00 | 0.43 | 0.87 | 0.16 | 4.57 |

Figure 4-4 Keyboard TAM Adjacent - Task Summary

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| ASK NO | TASK TYPE | TASK ESS. | COUNTERS REL | COUNTERS FAIL | COUNTERS SKIP | TIME TASK REALIZED MEAN | STD. | MIN | MAX | TIME TASK COMPLETED MEAN | STD. | MIN. | MAX. | TASK STRESS MEAN | STD. | MIN. | MAX. | TASK COHESIVENESS MEAN | STD. | MIN. | MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | COMT | 1.00 | 100 | 4 | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | | | | | | | | |
| 10 | MULT | 1.00 | 100 | 0 | 0 | 4.4 | 4.56 | 0.0 | 27.0 | 5.1 | 4.41 | 1.7 | 31.9 | 1.67 | 0.63 | 1.09 | 5.00 | 0.14 | 0.35 | 0.00 | 4.57 |
| 11 | MULT | 1.00 | 92. | 0. | 0. | 5.9 | 1.43 | 4.4 | 18.4 | 6.9 | 1.67 | 6.1 | 22.5 | 1.20 | 0.40 | 1.11 | 5.00 | 0.01 | 0.08 | 0.00 | 0.76 |
| 12 | MULT | 1.00 | 98 | 0 | 0. | 13.9 | 0.91 | 12.7 | 17.0 | 15.3 | 1.53 | 14.9 | 22.9 | 1.40 | 1.03 | 1.00 | 5.00 | 0.08 | 0.20 | 0.00 | 0.76 |
| 20 | MULT | 1.00 | 92 | 0 | 0 | 6.9 | 1.67 | 6.1 | 22.5 | 7.8 | 1.77 | 7.0 | 24.3 | 1.18 | 0.40 | 1.07 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 21 | MULT | 1.00 | 98 | 0 | 0 | 16.3 | 1.53 | 14.9 | 22.9 | 17.4 | 1.89 | 16.0 | 25.5 | 1.52 | 1.21 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 30 | MULT | 1.00 | 92 | 0 | 0 | 7.9 | 1.77 | 7.0 | 24.3 | 9.9 | 1.92 | 8.3 | 27.0 | 1.17 | 0.40 | 1.07 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 31 | MULT | 1.00 | 100 | 0 | 0 | 16.3 | 5.24 | 0.0 | 40.9 | 15.3 | 5.24 | 0.0 | 40.9 | 2.00 | 1.74 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 40 | COMT | 1.00 | 100 | 0 | 0 | 6.1 | 4.41 | 1.7 | 31.9 | 5.2 | 4.41 | 1.8 | 32.0 | | | | | | | | |
| 50 | MULT | 1.00 | 100 | 0. | 0 | 6.2 | 4.41 | 1.8 | 32.0 | 6.2 | 4.41 | 1.8 | 32.0 | 1.74 | 0.69 | 1.06 | 5.00 | 0.15 | 0.35 | 0.00 | 4.57 |
| 51 | MULT | 1.00 | 100. | 0. | 0 | 6.2 | 4.41 | 1.8 | 32.0 | 7.0 | 4.35 | 2.7 | 33.9 | 1.74 | 0.69 | 1.06 | 5.00 | 0.15 | 0.35 | 0.00 | 4.57 |
| 52 | MULT | 1.00 | 100 | 0 | 0 | 7.0 | 4.36 | 2.7 | 33.9 | 7.0 | 4.35 | 2.7 | 33.9 | 1.78 | 0.74 | 1.06 | 5.00 | 0.16 | 0.35 | 0.00 | 4.57 |
| 53 | MULT | 1.00 | 100 | 0 | 0 | 7.0 | 4.35 | 2.7 | 33.9 | 7.0 | 4.35 | 2.7 | 33.9 | 1.78 | 0.74 | 1.06 | 5.00 | 0.16 | 0.35 | 0.00 | 4.57 |
| 60 | MULT | 1.00 | 100. | 0 | 0. | 7.5 | 4.82 | 2.7 | 34.9 | 7.5 | 4.82 | 2.7 | 34.9 | 2.02 | 0.98 | 1.06 | 5.00 | 0.20 | 0.37 | 0.00 | 4.57 |
| 61 | MULT | 1.00 | 100 | 0 | 0. | 7.5 | 4.92 | 2.7 | 34.9 | 7.5 | 4.82 | 2.7 | 34.9 | 2.02 | 0.98 | 1.06 | 5.00 | 0.20 | 0.37 | 0.00 | 4.57 |
| 62 | MULT | 1.00 | 100 | 0. | 0 | 7.5 | 4.92 | 2.7 | 34.9 | 9.7 | 5.11 | 3.5 | 36.8 | 2.02 | 0.98 | 1.06 | 5.00 | 0.20 | 0.37 | 0.00 | 4.57 |
| 63 | MULT | 1.00 | 100 | 0 | 0 | 8.7 | 5.11 | 3.5 | 36.8 | 9.7 | 5.11 | 3.5 | 36.8 | 2.42 | 1.42 | 1.05 | 5.00 | 0.28 | 0.42 | 0.00 | 4.57 |
| 70 | FGMT | 1.00 | 72 | 0 | 0 | 11.1 | 2.44 | 10.2 | 33.9 | 12.1 | 2.44 | 11.2 | 34.8 | | | | | | | | |
| 90 | SING | 1.00 | 100. | 8. | 0. | 4.7 | 4.01 | 3.5 | 38.9 | 5.6 | 4.22 | 4.4 | 40.9 | 1.24 | 0.77 | 1.05 | 5.00 | 0.18 | 0.81 | 0.01 | 4.57 |
| 91 | SING | 1.00 | 92 | 4. | 0. | 13.5 | 2.54 | 12.2 | 36.8 | 14.3 | 2.77 | 12.7 | 38.6 | 2.38 | 0.45 | 2.00 | 5.00 | 0.76 | 0.62 | 0.29 | 4.57 |

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | STD | MIN | MAX | IDLE TIME MEAN | STD | MIN | MAX. | TOTAL TIME USED MEAN | STD | MIN. | MAX. | STRESS MEAN | STD. | MIN. | MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 17.00 | 13.6 | 4.2 | 0.0 | 29.9 | 2.7 | 1.2 | 0.0 | 11.0 | 16.3 | 5.2 | 0.0 | 40.9 | 1.52 | 0.47 | 1.00 | 3.79 |
| 2 | 17.00 | 2.7 | 1.0 | 0.0 | 6.5 | 13.6 | 4.3 | 0.0 | 34.4 | 16.3 | 5.2 | 0.0 | 40.9 | 0.65 | 0.29 | 0.00 | 2.62 |
| 3 | 17.00 | 2.7 | 1.0 | 0.0 | 6.5 | 13.6 | 4.3 | 0.0 | 34.4 | 16.3 | 5.2 | 0.0 | 40.9 | 0.65 | 0.29 | 0.00 | 2.62 |
| 4 | 17.00 | 15.2 | 4.9 | 0.0 | 30.6 | 1.1 | 0.4 | 0.0 | 2.3 | 16.3 | 5.2 | 0.0 | 40.9 | 1.57 | 0.44 | 1.00 | 3.75 |

75 SUCCESSFUL MISSIONS

25 UNSUCCESSFUL MISSIONS

Figure 4-5 Keyboard TAM Remote - Task and Mission Summaries

4.1.2.2 Test and Demonstration Results (Cont'd)

The read CRT TAM also has different parameters associated with it, depending upon whether the instructor is reading the adjacent CRT or a remote one. Task 10, VISUALLY ACCESS, is the only task in which the parameter set differs from the adjacent to the remote display. The parameter sets used to quantify the visual access time from the instructor position to the adjacent and remote displays are the same as those given for manually accessing the keyboard from adjacent and remote CRTs. A time of 35.0 seconds was assigned to the TAM. The results of running these TAMs with the above values are shown in Figures 4-6 to 4-9. Table 4-2 restates the values obtained from the Mission Summary Reports. These are the values which will be assigned to the READ tasks in the Instructor Task Description.

Table 4-2 Restated Mission Summary Report Values (No. 1)

| | Time Mission Completed (in seconds) | | | | Missions | |
|---|---|---|---|---|---|---|
| | Mean | Min. | Max. | Std. | Successful | Unsuccessful |
| Adjacent | 31.0 | 27.0 | 32.6 | 1.06 | 100 | 0 |
| Remote | 31.3 | 27.0 | 32.8 | 1.12 | 100 | 0 |

As can be seen from these results, the time required to read a display on a remote CRT is 0.3 second greater than that required for the adjacent CRT. The number of successful missions was equal (100%) for both displays.

The manual access task in the push button TAM can have four different parameter sets associated with it. The selection of the proper parameter set was dependent on whether the push button was isolated or in a bank, and remote from or adjacent to the CRT which displays the push button controls. The parameter sets are shown in Appendix G. The manual access task also has four parameter sets associated with it. These tasks are dependent on the same conditions as the visual access tasks. The parameter sets for tasks 10 and 20 differed as a function of push button and CRT control. There was always a verification of the new displays. The time allowed for this TAM to be completed was 15 seconds. The results of running these TAMs with the preceding data can be found in Figures 4-10 to 4-17. Table 4-3 restates the values obtained from the Mission Summary Report.

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK NO | TASK TYPE | TASK ASS | COUNTERS REL | COUNTERS FAIL | COUNTERS SKIP | TIME TASK REALIZED MEAN | TIME TASK REALIZED STD | TIME TASK REALIZED MIN | TIME TASK REALIZED MAX | TIME TASK COMPLETED MEAN | TIME TASK COMPLETED STD | TIME TASK COMPLETED MIN | TIME TASK COMPLETED MAX | TASK STRESS MEAN | TASK STRESS STD | TASK STRESS MIN | TASK STRESS MAX. | TASK COHESIVENESS MEAN | TASK COHESIVENESS STD. | TASK COHESIVENESS MIN. | TASK COHESIVENESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SGMT | 1.00 | 100 | 7 | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 10.3 | 0.01 | 10.4 | 10.4 | | | | | | | | |
| 3 | SGMT | 1.00 | 93 | 0 | 0 | 11.5 | 0.09 | 11.3 | 11.6 | 12.5 | 0.10 | 12.3 | 12.6 | | | | | | | | |
| 10 | MULT | 1.00 | 93 | 0 | 0 | 10.3 | 0.01 | 10.4 | 10.4 | 11.4 | 0.07 | 11.2 | 11.5 | 2.37 | 0.00 | 2.39 | 2.39 | 1.00 | 0.00 | 1.00 | 1.00 |
| 40 | SGMT | 1.00 | 93 | 0 | 0 | 11.4 | 0.09 | 11.2 | 11.5 | 11.5 | 0.07 | 11.3 | 11.6 | | | | | | | | |
| 30 | MULT | 1.00 | 93 | 0 | 0 | 12.5 | 0.10 | 12.3 | 12.6 | 12.5 | 0.10 | 12.3 | 12.6 | 2.44 | 0.01 | 2.43 | 2.45 | 1.00 | 0.00 | 1.00 | 1.00 |
| 51 | MULT | 1.00 | 93 | 0 | 0 | 12.5 | 0.10 | 12.3 | 12.6 | 12.5 | 0.10 | 12.3 | 12.6 | 2.44 | 0.01 | 2.43 | 2.45 | 1.00 | 0.00 | 1.00 | 1.00 |
| 52 | MULT | 1.00 | 93 | 0 | 0 | 12.5 | 0.10 | 12.3 | 12.6 | 12.5 | 0.10 | 12.3 | 12.6 | 2.44 | 0.01 | 2.43 | 2.45 | 1.00 | 0.00 | 1.00 | 1.00 |
| 53 | MULT | 1.00 | 93 | 0 | 0 | 12.5 | 0.10 | 12.3 | 12.6 | 13.9 | 0.21 | 13.5 | 14.3 | 2.44 | 0.01 | 2.43 | 2.45 | 1.00 | 0.00 | 1.00 | 1.00 |
| 60 | MULT | 1.00 | 93 | 0 | 0 | 13.9 | 0.21 | 13.5 | 14.3 | 13.9 | 0.21 | 13.5 | 14.3 | 2.42 | 0.01 | 2.39 | 2.44 | 1.00 | 0.00 | 1.00 | 1.00 |
| 61 | MULT | 1.00 | 93 | 0 | 0 | 13.9 | 0.21 | 13.5 | 14.3 | 13.9 | 0.21 | 13.5 | 14.3 | 2.42 | 0.01 | 2.39 | 2.44 | 1.00 | 0.00 | 1.00 | 1.00 |
| 62 | MULT | 1.00 | 93 | 0 | 0 | 13.7 | 0.21 | 13.5 | 14.3 | 13.9 | 0.21 | 13.5 | 14.3 | 2.42 | 0.01 | 2.39 | 2.44 | 1.00 | 0.00 | 1.00 | 1.00 |
| 63 | MULT | 1.00 | 100 | 0 | 0 | 13.7 | 0.94 | 10.4 | 14.3 | 31.[illegible] | 1.06 | 27.0 | 32.6 | 2.41 | 0.05 | 2.21 | 2.44 | 1.00 | 0.00 | 1.00 | 1.00 |

Figure 4-6  Read TAM Adjacent - Task Summary

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD. | BUSY TIME MIN. | BUSY TIME MAX. | IDLE TIME MEAN | IDLE TIME STD. | IDLE TIME MIN. | IDLE TIME MAX. | TOTAL TIME USED MEAN | TOTAL TIME USED STD. | TOTAL TIME USED MIN. | TOTAL TIME USED MAX. | STRESS MEAN | STRESS STD. | STRESS MIN. | STRESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 35.00 | 19.7 | 0.8 | 16.6 | 21.1 | 11.4 | 0.3 | 10.4 | 11.5 | 31.0 | 1.1 | 27.0 | 32.6 | 0.94 | 0.05 | 0.75 | 0.98 |
| 2 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.00 | 0.00 | 1.00 | 1.00 |
| 3 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.00 | 0.00 | 1.00 | 1.00 |
| 4 | 35.00 | 19.7 | 0.8 | 16.6 | 21.1 | 11.4 | 0.3 | 10.4 | 11.5 | 31.0 | 1.1 | 27.0 | 32.6 | 0.94 | 0.05 | 0.75 | 0.98 |

100 SUCCESSFUL MISSIONS

0 UNSUCCESSFUL MISSIONS

Figure 4-7 Read TAM Adjacent - Mission Summary

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| ASK NO | TASK TYPE | TASK ASS | COUNTERS REL | COUNTERS FAIL | COUNTERS SKIP | TIME TASK REALIZED MEAN | TIME TASK REALIZED STD | TIME TASK REALIZED MIN. | TIME TASK REALIZED MAX | TIME TASK COMPLETED MEAN | TIME TASK COMPLETED STD | TIME TASK COMPLETED MIN. | TIME TASK COMPLETED MAX | TASK STRESS MEAN | TASK STRESS STD | TASK STRESS MIN | TASK STRESS MAX. | TASK COHESIVENESS MEAN | TASK COHESIVENESS STD. | TASK COHESIVENESS MIN. | TASK COHESIVENESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SGMI | 1.00 | 100 | 7 | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 10.3 | 0.01 | 10.4 | 10.4 | | | | | | | | |
| 3 | SGMI | 1.00 | 93 | 0 | 0 | 11.9 | 0.18 | 11.6 | 12.2 | 12.8 | 0.19 | 12.6 | 13.2 | | | | | | | | |
| 10 | MULT | 1.00 | 93 | 0 | 0 | 10.3 | 0.01 | 10.4 | 10.4 | 11.7 | 0.19 | 11.5 | 12.1 | 2.42 | 0.00 | 2.42 | 2.42 | 1.00 | 0.00 | 1.00 | 1.00 |
| 40 | SGMI | 1.00 | 93 | 0 | 0 | 11.7 | 0.18 | 11.5 | 12.1 | 11.8 | 0.19 | 11.6 | 12.2 | | | | | | | | |
| 50 | MULT | 1.00 | 93 | 0 | 0 | 12.9 | 0.18 | 12.6 | 13.2 | 12.8 | 0.19 | 12.6 | 13.2 | 2.46 | 0.01 | 2.45 | 2.49 | 1.00 | 0.00 | 1.00 | 1.00 |
| 51 | MULT | 1.00 | 93 | 0 | 0 | 12.9 | 0.18 | 12.6 | 13.2 | 12.8 | 0.19 | 12.6 | 13.2 | 2.46 | 0.01 | 2.45 | 2.49 | 1.00 | 0.00 | 1.00 | 1.00 |
| 52 | MULT | 1.00 | 93 | 0 | 0 | 12.9 | 0.18 | 12.6 | 13.2 | 12.8 | 0.19 | 12.6 | 13.2 | 2.46 | 0.01 | 2.45 | 2.49 | 1.00 | 0.00 | 1.00 | 1.00 |
| 53 | MULT | 1.00 | 93 | 0 | 0 | 12.8 | 0.18 | 12.6 | 13.2 | 14.3 | 0.25 | 13.8 | 14.8 | 2.46 | 0.01 | 2.45 | 2.49 | 1.00 | 0.00 | 1.00 | 1.00 |
| 60 | MULT | 1.00 | 93 | 0 | 0 | 14.3 | 0.25 | 13.0 | 14.9 | 14.3 | 0.25 | 13.8 | 14.8 | 2.44 | 0.02 | 2.41 | 2.48 | 1.00 | 0.00 | 1.00 | 1.00 |
| 61 | MULT | 1.00 | 93 | 0 | 0 | 14.3 | 0.25 | 13.0 | 14.9 | 14.3 | 0.25 | 13.8 | 14.8 | 2.44 | 0.02 | 2.41 | 2.48 | 1.00 | 0.00 | 1.00 | 1.00 |
| 62 | TEST | 1.00 | 93 | 0 | 0 | 14.3 | 0.25 | 13.0 | 14.9 | 14.3 | 0.25 | 13.8 | 14.8 | 2.44 | 0.02 | 2.41 | 2.48 | 1.00 | 0.00 | 1.00 | 1.00 |
| 63 | MULT | 1.00 | 100 | 0 | 0 | 14.9 | 1.04 | 10.4 | 14.9 | 31.3 | 1.12 | 27.0 | 32.8 | 2.43 | 0.06 | 2.21 | 2.48 | 1.00 | 0.00 | 1.00 | 1.00 |

Figure 4-8 Read TAM Remote - Task Summary

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD. | BUSY TIME MIN. | BUSY TIME MAX. | IDLE TIME MEAN | IDLE TIME STD. | IDLE TIME MIN. | IDLE TIME MAX. | TOTAL TIME USED MEAN | TOTAL TIME USED STD. | TOTAL TIME USED MIN. | TOTAL TIME USED MAX. | STRESS MEAN | STRESS STD. | STRESS MIN. | STRESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 35.00 | 19.9 | 0.9 | 16.6 | 21.3 | 11.4 | 0.3 | 10.4 | 11.5 | 31.3 | 1.1 | 27.0 | 32.8 | 0.95 | 0.06 | 0.75 | 1.00 |
| 2 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.00 | 0.00 | 1.00 | 1.00 |
| 3 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.00 | 0.00 | 1.00 | 1.00 |
| 4 | 35.00 | 19.9 | 0.7 | 16.6 | 21.3 | 11.4 | 0.3 | 10.4 | 11.5 | 31.3 | 1.1 | 27.0 | 32.8 | 0.95 | 0.06 | 0.75 | 1.00 |

100 SUCCESSFUL MISSIONS

0 UNSUCCESSFUL MISSIONS

Figure 4-9 Read TAM Remote - Mission Summary

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| ASK NO | TASK TYPE | TASK SUC | --NUMBERS REL | F.U. | SKIP | ----TIME TASK REALIZED---- MEAN | STD | MIN | MAX | ----TIME TASK COMPLETED---- MEAN | STD | MIN | MAX | ----TASK STRESS---- MEAN | STD | MIN | MAX. | -TASK COHESIVENESS- MEAN | STD. | MIN. | MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CGMT | 1 00 | 100 | 5 | 0 | 0 [illegible] | 0 00 | 0 0 | 0 0 | 0 0 | 0 00 | 0 0 | 0 0 | | | | | | | | |
| 10 | [illegible] | 1 00 | 210 | [illegible] | 0 | 8 1 | 11 21 | 0 9 | 93 7 | 10 8 | 11 79 | 2 6 | 84 3 | 2 00 | 1 31 | 1 00 | 5.00 | 0.64 | 1 45 | 0 00 | 4.57 |
| 20 | [illegible] | 1 00 | [illegible] | [illegible] | 0 | 11 9 | 11 [illegible] | 4 6 | 72 5 | 13 7 | 12 40 | 5 7 | 82 8 | 1 87 | 1 53 | 1 00 | 5 00 | 0.00 | 0.00 | 0 00 | 0.00 |
| 30 | [illegible] | 1 00 | 110 | [illegible] | 0 | 13 7 | 12 40 | 5 7 | 92 9 | 13.7 | 12.37 | 5.7 | 82 7 | 1 94 | 1 60 | 1 00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 40 | [illegible] | [illegible] | 210 | [illegible] | 0 | 10 8 | 11 79 | 2 6 | 96 3 | 10.9 | 11 79 | 2 7 | 85.4 | | | | | | | | |
| 50 | [illegible] | 1 00 | 210 | [illegible] | 0 | 10 9 | 11 77 | 2 7 | 86 4 | 10 9 | 11 79 | 2 7 | 86 4 | 2 20 | 1 55 | 1 00 | 5.00 | 0 68 | 1.45 | 0.00 | 4.57 |
| 51 | [illegible] | 1 00 | 210 | [illegible] | 0 | 10 9 | 11 79 | 2 7 | 96 4 | 12 0 | 12 13 | 3 6 | 89 4 | 2 20 | 1 55 | 1 00 | 5.00 | 0 68 | 1.45 | 0 00 | 4.57 |
| 52 | [illegible] | 1 00 | 210 | [illegible] | 0. | 12 0 | 12 13 | 3.6 | 88.4 | 12 0 | 12.13 | 3 6 | 89 4 | 2 24 | 1 60 | 1 00 | 5.00 | 0.69 | 1.45 | 0.00 | 4.57 |
| 53 | [illegible] | 1 00 | 210 | 0 | 0 | 12 0 | 12 13 | 3 6 | 88.4 | 12 0 | 12 13 | 3.6 | 88 4 | 2 24 | 1 60 | 1 00 | 5.00 | 0.69 | 1.45 | 0.00 | 4.57 |
| 60 | [illegible] | 1 00 | 210 | [illegible] | 0 | 12 6 | 12 39 | 3 6 | 97 4 | 12 6 | 12 39 | 3.6 | 89 4 | 2 42 | 1 62 | 1 00 | 5 00 | 0.72 | 1.44 | 0.00 | 4.57 |
| 61 | [illegible] | 1 00 | 210 | [illegible] | 0 | 12 5 | 12 39 | 3 5 | 97 4 | 12 6 | 12 39 | 3 6 | 89 4 | 2 42 | 1 62 | 1 00 | 5 00 | 0.72 | 1.44 | 0.00 | 4.57 |
| 62 | [illegible] | 1 00 | 210 | [illegible] | 0 | 12 6 | 12 39 | 3 6 | 97 4 | 13.8 | 12 75 | 4 6 | 91 5 | 2.42 | 1 62 | 1 00 | 5.00 | 0.72 | 1 44 | 0 00 | 4.57 |
| 63 | [illegible] | 1 00 | 210 | [illegible] | 0 | 13 8 | 12 75 | 4 6 | 91 5 | 13 8 | 12.75 | 4 6 | 91 5 | 2.56 | 1.74 | 1.00 | 5.00 | 0.75 | 1.44 | 0.00 | 4.57 |
| 70 | [illegible] | 1 00 | 110 | [illegible] | 0 | 17 5 | 13 97 | 7.8 | 88.4 | 19 5 | 13.89 | 8.9 | 89 4 | | | | | | | | |
| 90 | [illegible] | 1 00 | 95 | 3 | 0 | 0 0 | 0 00 | 0 0 | 0 0 | 1 0 | 0.05 | 0 9 | 1 1 | 1.00 | 0 00 | 1 00 | 1 00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 91 | [illegible] | 1 00 | 110 | 26 | 0 | 19 [illegible] | 14 27 | 9.4 | 91 5 | 21 2 | 14.74 | 10.1 | 93.7 | 3.24 | 1 67 | 1 22 | 5.00 | 2 30 | 2.13 | 0.06 | 4.57 |
| 00 | [illegible] | 1 00 | 100 | 0 | 0 | 17 5 | 14 51 | 0 0 | 93.7 | 17 5 | 14.51 | 0 0 | 93.7 | | | | | | | | |

Figure 4-10 Push Button TAM Bank Remote - Task Summary

MISSION SUMMARY REPORT

| PERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD. | BUSY TIME MIN. | BUSY TIME MAX. | IDLE TIME MEAN | IDLE TIME STD. | IDLE TIME MIN. | IDLE TIME MAX. | TOTAL TIME USED MEAN | TOTAL TIME USED STD. | TOTAL TIME USED MIN. | TOTAL TIME USED MAX. | STRESS MEAN | STRESS STD. | STRESS MIN. | STRESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 15.00 | 13.6 | 11.8 | 0.0 | 76.5 | 2.0 | 2.4 | 0.0 | 15.0 | 16.5 | 14.0 | 0.0 | 91.5 | 1.59 | 0.97 | 0.00 | 4.32 |
| 2 | 15.00 | 3.2 | 4.0 | 0.0 | 27.7 | 8.1 | 9.4 | 0.0 | 55.0 | 11.4 | 11.9 | 0.0 | 82.7 | 0.79 | 0.57 | 0.41 | 3.46 |
| 3 | 15.00 | 3.2 | 4.0 | 0.0 | 27.7 | 6.1 | 9.4 | 0.0 | 55.0 | 11.4 | 11.9 | 0.0 | 82.7 | 0.79 | 0.57 | 0.41 | 3.46 |
| 4 | 15.00 | 16.1 | 13.7 | 0.0 | 80.0 | 1.4 | 0.9 | 0.0 | 5.7 | 17.5 | 14.5 | 0.0 | 93.7 | 1.86 | 0.98 | 1.00 | 4.44 |

67 SUCCESSFUL MISSIONS

33 UNSUCCESSFUL MISSIONS

Figure 4-11 Push Button TAM Bank Remote - Mission Summary

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| ASK NO | TASK TYPE | TASK ESS | COUNTERS REL | COUNTERS FAIL | COUNTERS SKIP | TIME TASK REALIZED MEAN | TIME TASK REALIZED STD | TIME TASK REALIZED MIN | TIME TASK REALIZED MAX | TIME TASK COMPLETED MEAN | TIME TASK COMPLETED STD. | TIME TASK COMPLETED MIN | TIME TASK COMPLETED MAX | TASK STRESS MEAN | TASK STRESS STD. | TASK STRESS MIN. | TASK STRESS MAX. | TASK COHESIVENESS MEAN | TASK COHESIVENESS STD. | TASK COHESIVENESS MIN. | TASK COHESIVENESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EGMI | 1.00 | 100 | 5 | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | | | | | | | | |
| 10 | MULT | 1.00 | 1?9 | 0 | 0 | 4.9 | 4.29 | 0.9 | 28.6 | 6.6 | 4.47 | 1.9 | 32.4 | 1.46 | 0.75 | 1.00 | 5.00 | 0.17 | 0.66 | 0.00 | 4.57 |
| 20 | MULT | 1.00 | 77 | 0 | 0 | [illegible] | [illegible] | 4.0 | 23.9 | 9.5 | 3.77 | 3.0 | 28.7 | 1.10 | 0.91 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 30 | MULT | 1.00 | 97 | 0 | 0 | 8.3 | 3.97 | 5.0 | 28.7 | 8.5 | 3.95 | 5.0 | 29.6 | 1.22 | 0.95 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 40 | COMT | 1.00 | 19? | 0 | 0 | 6.6 | 4.47 | 1.7 | 33.4 | 5.7 | 4.47 | 2.0 | 32.5 | | | | | | | | |
| 50 | MULT | 1.00 | 1?? | 0 | 0 | 6.7 | 4.47 | 2.0 | 32.5 | 6.7 | 4.47 | 2.0 | 32.5 | 1.46 | 0.83 | 1.00 | 5.00 | 0.17 | 0.66 | 0.00 | 4.57 |
| 51 | MULT | 1.00 | 1?? | 0 | 0 | 6.7 | 4.47 | 2.0 | 32.5 | 7.5 | 4.54 | 3.0 | 34.3 | 1.46 | 0.92 | 1.00 | 5.00 | 0.17 | 0.66 | 0.00 | 4.57 |
| 52 | MULT | 1.00 | 1?? | 0 | 0 | 7.5 | 4.54 | 3.0 | 34.3 | 7.5 | 4.54 | 3.0 | 34.3 | 1.48 | 0.97 | 1.00 | 5.00 | 0.17 | 0.66 | 0.00 | 4.57 |
| 53 | MULT | 1.00 | 1?? | 0 | 0 | 7.5 | 4.54 | 3.0 | 34.3 | 7.5 | 4.54 | 3.0 | 34.3 | 1.48 | 0.87 | 1.00 | 5.00 | 0.17 | 0.66 | 0.00 | 4.57 |
| 60 | MULT | 1.00 | 18? | 0 | 0 | 8.1 | 4.89 | 3.0 | 35.3 | 8.1 | 4.89 | 3.0 | 35.3 | 1.68 | 1.04 | 1.00 | 5.00 | 0.21 | 0.67 | 0.00 | 4.57 |
| 61 | MULT | 1.00 | 1?? | 0 | 0 | 8.1 | 4.87 | 3.0 | 35.3 | 9.1 | 4.89 | 3.0 | 35.3 | 1.68 | 1.04 | 1.00 | 5.00 | 0.21 | 0.57 | 0.00 | 4.57 |
| 62 | MULT | 1.00 | 1?? | 0 | 0 | 8.1 | 4.99 | 3.0 | 35.3 | 9.0 | 5.04 | 4.0 | 37.2 | 1.60 | 1.04 | 1.00 | 5.00 | 0.21 | 0.57 | 0.00 | 4.57 |
| 63 | MULT | 1.00 | [illegible] | [illegible] | 0 | 9.0 | [illegible] | 4.0 | 37.2 | 9.0 | 5.04 | 4.0 | 37.2 | 1.79 | 1.24 | 1.00 | 5.00 | 0.23 | 0.68 | 0.00 | 4.57 |
| 70 | LGRI | 1.00 | 77 | [illegible] | 0 | 10.5 | 4.66 | 7.1 | 34.3 | 11.5 | 4.67 | 8.1 | 35.3 | | | | | | | | |
| 80 | SING | 1.00 | 75 | [illegible] | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 1.0 | 0.04 | 0.9 | 1.1 | | | | | | | | |
| 91 | SING | 1.00 | 57 | 5 | 0 | 12.3 | 5.06 | 0.7 | 37.2 | 13.2 | 5.40 | 9.7 | 39.9 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 100 | EGMT | 1.00 | 150 | 5 | 0 | 12.0 | 6.19 | 0.0 | 38.9 | 12.0 | 6.19 | 0.0 | 39.9 | 1.97 | 1.27 | 1.05 | 5.00 | 0.80 | 1.53 | 0.01 | 4.57 |

Figure 4-12 Push Button TAM Bank Adjacent - Task Summary

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD | BUSY TIME MIN. | BUSY TIME MAX. | IDLE TIME MEAN | IDLE TIME STD. | IDLE TIME MIN. | IDLE TIME MAX. | TOTAL TIME USED MEAN | TOTAL TIME USED STD. | TOTAL TIME USED MIN. | TOTAL TIME USED MAX. | STRESS MEAN | STRESS STD. | STRESS MIN. | STRESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 15.00 | 9.0 | 5.0 | 0.0 | 31.5 | 2.2 | 1.0 | 0.0 | 7.[illegible] | 11.2 | 5.9 | 0.0 | 37.2 | 1.13 | 0.56 | 0.00 | 3.53 |
| 2 | 15.00 | 2.3 | [illegible] | 0.0 | 14.0 | 5.4 | 2.7 | 0.0 | 20.0 | 7.7 | 4.5 | 0.0 | 28.6 | 0.62 | 0.25 | 0.40 | 1.95 |
| 3 | 15.00 | 2.3 | [illegible] | 0.0 | 14.0 | 5.4 | 2.7 | 0.0 | 20.0 | 7.7 | 4.5 | 0.0 | 28.6 | 0.62 | 0.25 | 0.40 | 1.75 |
| 4 | 15.00 | 10.8 | 5.0 | 0.0 | 35.6 | 1.2 | 0.5 | 0.0 | 3.4 | 12.0 | 6.2 | 0.0 | 38.9 | 1.34 | 0.56 | 1.00 | 3.79 |

08 SUCCESSFUL MISSIONS

12 UNSUCCESSFUL MISSIONS

Figure 4-13 Push Button TAM Bank Adjacent - Mission Summary

## TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK NO | TASK TYPE | TASK ESS | COUNTERS ALL | COUNTERS FAIL | COUNTERS SKIP | TIME TASK REALIZED MEAN | TIME TASK REALIZED STD | TIME TASK REALIZED MIN | TIME TASK REALIZED MAX | TIME TASK COMPLETED MEAN | TIME TASK COMPLETED STD | TIME TASK COMPLETED MIN | TIME TASK COMPLETED MAX | TASK STRESS MEAN | TASK STRESS STD | TASK STRESS MIN. | TASK STRESS MAX | TASK COHESIVENESS MEAN | TASK COHESIVENESS STD. | TASK COHESIVENESS MIN. | TASK COHESIVENESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EGMT | 1.00 | 100 | 5 | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | | | | | | | | |
| 10 | MULT | 1.00 | 195 | 0 | 0 | 5.7 | 10.20 | 0.9 | 94.3 | 7.7 | 10.72 | 2.3 | 87.4 | 1.48 | 0.99 | 1.00 | 5.00 | 0.26 | 0.92 | 0.00 | 4.57 |
| 20 | MULT | 1.00 | 98 | 0 | 0 | 8.0 | 12.08 | 4.4 | 93.7 | 10.3 | 12.55 | 5.4 | 84.6 | 1.35 | 1.10 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 30 | MULT | 1.00 | 98 | 0 | 0 | 10.3 | 12.55 | 5.4 | 94.6 | 10.3 | 12.53 | 5.4 | 84.5 | 1.39 | 1.16 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 40 | EGMT | 1.00 | 196 | 0 | 0 | 7.7 | 10.72 | 2.3 | 97.4 | 7.8 | 10.72 | 2.4 | 87.5 | | | | | | | | |
| 50 | MULT | 1.00 | 195 | 0 | 0 | 7.9 | 10.72 | 2.4 | 97.5 | 7.8 | 10.72 | 2.4 | 89.5 | 1.55 | 0.95 | 1.00 | 5.00 | 0.27 | 0.92 | 0.00 | 4.57 |
| 51 | MULT | 1.00 | 195 | 0 | 0 | 7.3 | 10.72 | 2.4 | 97.5 | 8.6 | 10.90 | 3.4 | 91.5 | 1.55 | 0.95 | 1.00 | 5.00 | 0.27 | 0.92 | 0.00 | 4.57 |
| 52 | MULT | 1.00 | 195 | 0 | 0 | 8.6 | 10.90 | 3.4 | 91.5 | 8.6 | 10.90 | 3.4 | 91.5 | 1.56 | 0.97 | 1.00 | 5.00 | 0.27 | 0.92 | 0.00 | 4.57 |
| 53 | MULT | 1.00 | 195 | 0 | 0 | 8.6 | 10.90 | 3.4 | 91.5 | 8.6 | 10.90 | 3.4 | 91.5 | 1.56 | 0.97 | 1.00 | 5.00 | 0.27 | 0.92 | 0.00 | 4.57 |
| 60 | MULT | 1.00 | 195 | 0 | 0 | 9.2 | 11.12 | 3.4 | 92.6 | 9.2 | 11.12 | 3.4 | 92.6 | 1.74 | 1.07 | 1.00 | 5.00 | 0.30 | 0.92 | 0.00 | 4.57 |
| 61 | MULT | 1.00 | 196 | 0 | 0 | 9.2 | 11.12 | 3.4 | 92.6 | 9.2 | 11.12 | 3.4 | 92.5 | 1.74 | 1.07 | 1.00 | 5.00 | 0.30 | 0.92 | 0.00 | 4.57 |
| 62 | MULT | 1.00 | 195 | 0 | 0 | 9.2 | 11.12 | 3.4 | 92.6 | 10.1 | 11.32 | 4.4 | 94.5 | 1.74 | 1.07 | 1.00 | 5.00 | 0.30 | 0.92 | 0.00 | 4.57 |
| 63 | MULT | 1.00 | 194 | 0 | 0 | 10.1 | 11.32 | 4.4 | 94.5 | 10.1 | 11.32 | 4.4 | 94.5 | 1.83 | 1.22 | 1.00 | 5.00 | 0.32 | 0.92 | 0.00 | 4.57 |
| 70 | EGMT | 1.00 | 93 | 0 | 0 | 12.9 | 13.69 | 7.6 | 91.5 | 13.9 | 13.69 | 8.6 | 92.6 | | | | | | | | |
| 90 | SING | 1.00 | 97 | 7 | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 1.0 | 0.05 | 0.9 | 1.2 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 91 | SING | 1.00 | 96 | 10 | 0 | 14.8 | 14.03 | 9.1 | 94.5 | 15.6 | 14.39 | 9.8 | 95.6 | 2.01 | 1.26 | 1.18 | 5.00 | 0.81 | 1.55 | 0.05 | 4.57 |
| 100 | EGMT | 1.00 | 100 | 0 | 0 | 11.9 | 10.97 | 0.0 | 96.6 | 11.8 | 10.89 | 0.0 | 95.6 | | | | | | | | |

Figure 4-14 Push Button TAM Isolated Remote - Task Summary

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD | BUSY TIME MIN | BUSY TIME MAX | IDLE TIME MEAN | IDLE TIME STD. | IDLE TIME MIN. | IDLE TIME MAX. | TOTAL TIME USED MEAN | TOTAL TIME USED STD. | TOTAL TIME USED MIN. | TOTAL TIME USED MAX. | STRESS MEAN | STRESS STD. | STRESS MIN. | STRESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 15.00 | 8.9 | 8.8 | 0.0 | 76.5 | 2.2 | 1.9 | 0.0 | 18.0 | 11.1 | 10.7 | 0.0 | 94.5 | 1.13 | 0.59 | 0.00 | 4.39 |
| 2 | 15.00 | 2.3 | 2.9 | 0.0 | 21.8 | 5.2 | 6.6 | 0.0 | 62.8 | 7.5 | 9.2 | 0.0 | 84.5 | 0.68 | 0.40 | 0.49 | 3.59 |
| 3 | 15.00 | 2.3 | 2.9 | 0.0 | 21.8 | 5.2 | 6.6 | 0.0 | 62.8 | 7.5 | 9.2 | 0.0 | 84.5 | 0.68 | 0.40 | 0.49 | 3.59 |
| 4 | 15.00 | 10.7 | 10.1 | 0.0 | 89.9 | 1.2 | 0.8 | 0.0 | 6.7 | 11.8 | 10.9 | 0.0 | 96.6 | 1.32 | 0.56 | 1.00 | 4.49 |

93 SUCCESSFUL MISSIONS

7 UNSUCCESSFUL MISSIONS

Figure 4-15 Push Button TAM Isolated Remote - Mission Summary

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| ASK NO | TASK TYPE | TASK ESS | -- COUNTERS--- REL. | FAIL | SKIP | -----TIME TASK REALIZED---- MEAN | STD. | MIN. | MAX. | ----TIME TASK COMPLETED---- MEAN | STD. | N. | MAX | ----TASK STRESS---- MEAN | STD. | MIN. | MAX. | -TASK COHESIVENESS- MEAN | STD. | MIN. | MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CGMT | 1.00 | 100 | 0 | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | | | | | | | | |
| 10 | MULT | 1.00 | 100 | 0 | 0 | 3.9 | 3.30 | 0.9 | 24.9 | 5.1 | 3.44 | 1.7 | 29.1 | 1.20 | 0.39 | 1.00 | 5.00 | 0.06 | 0.34 | 0.00 | 4.57 |
| 20 | MULT | 1.00 | 95 | 5 | 0 | 4.5 | 1.91 | 3.8 | 21.9 | 5.8 | 2.25 | 4.9 | 25.0 | 1.05 | 0.41 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 30 | MULT | 1.00 | 95 | 0 | 0 | 6.9 | 2.25 | 4.9 | 25.0 | 5.8 | 2.25 | 4.9 | 24.9 | 1.05 | 0.42 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 40 | CGMT | 1.00 | 100 | 0 | 0 | 5.1 | 3.44 | 1.7 | 29.1 | 5.2 | 3.44 | 1.8 | 29.2 | | | | | | | | |
| 50 | MULT | 1.00 | 100 | 0 | 0 | 5.2 | 3.44 | 1.8 | 29.2 | 5.2 | 3.44 | 1.8 | 29.2 | 1.24 | 0.46 | 1.00 | 5.00 | 0.07 | 0.34 | 0.00 | 4.57 |
| 51 | MULT | 1.00 | 100 | 0 | 0 | 5.2 | 3.44 | 1.8 | 29.2 | 6.1 | 3.34 | 2.8 | 31.1 | 1.24 | 0.46 | 1.00 | 5.00 | 0.07 | 0.34 | 0.00 | 4.57 |
| 52 | MULT | 1.00 | 100 | 0 | 0 | 6.1 | 3.34 | 2.0 | 31.1 | 6.1 | 3.34 | 2.0 | 31.1 | 1.23 | 0.46 | 1.00 | 5.00 | 0.06 | 0.34 | 0.00 | 4.57 |
| 53 | MULT | 1.00 | 100 | 0 | 0 | 6.1 | 3.34 | 2.8 | 31.1 | 6.1 | 3.34 | 2.8 | 31.1 | 1.23 | 0.46 | 1.00 | 5.00 | 0.06 | 0.34 | 0.00 | 4.57 |
| 60 | MULT | 1.00 | 100 | 0 | 0 | 6.6 | 3.77 | 2.8 | 32.1 | 6.6 | 3.77 | 2.8 | 32.1 | 1.36 | 0.54 | 1.00 | 5.00 | 0.09 | 0.34 | 0.00 | 4.57 |
| 61 | MULT | 1.00 | 100 | 0 | 0 | 6.6 | 3.77 | 2.8 | 32.1 | 6.6 | 3.77 | 2.8 | 32.1 | 1.36 | 0.54 | 1.00 | 5.00 | 0.09 | 0.34 | 0.00 | 4.57 |
| 62 | MULT | 1.00 | 100 | 0 | 0 | 6.6 | 3.77 | 2.8 | 32.1 | 7.4 | 3.65 | 3.8 | 34.0 | 1.36 | 0.54 | 1.00 | 5.00 | 0.09 | 0.34 | 0.00 | 4.57 |
| 63 | MULT | 1.00 | 100 | 0 | 0 | 7.4 | 3.65 | 3.8 | 34.0 | 7.4 | 3.65 | 3.8 | 34.0 | 1.36 | 0.55 | 1.00 | 5.00 | 0.09 | 0.34 | 0.00 | 4.57 |
| 70 | FGMT | 1.00 | 95 | 5 | 0 | 8.8 | 2.61 | 7.1 | 31.1 | 9.8 | 2.61 | 8.1 | 32.1 | | | | | | | | |
| 80 | SING | 1.00 | 97 | 3 | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 1.0 | 0.05 | 0.9 | 1.1 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 81 | SING | 1.00 | 95 | 5 | 0 | 10.4 | 2.78 | 3.7 | 34.0 | 11.2 | 2.91 | 9.7 | 36.0 | 1.35 | 0.57 | 1.05 | 5.00 | 0.17 | 0.65 | 0.02 | 4.57 |
| 100 | CGMT | 1.00 | 100 | 0 | 0 | 10.3 | 3.75 | 0.0 | 36.0 | 10.3 | 3.76 | 0.0 | 36.0 | | | | | | | | |

Figure 4-16 Push Button TAM Isolated Adjacent - Task Summary

MISSION SUMMARY REPORT

| OPERATOR | TIME | ----- | BUSY TIME | ----- | ----- | ----- | IDLE TIME | ----- | ----- | ----- | TOTAL TIME USED | ----- | ----- | ----- | STRESS | ----- | ----- |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | AVAILABLE | MEAN | STD | MIN | MAX | MEAN | STD. | MIN. | MAX. | MEAN | STD. | MIN. | MAX. | MEAN | STD. | MIN. | MAX. |
| 1 | 15.00 | 7.5 | 2.9 | 0.0 | 26.8 | 2.1 | 0.8 | 0.0 | 7.2 | 9.6 | 3.7 | 0.0 | 34.0 | 0.78 | 0.29 | 0.00 | 3.29 |
| 2 | 15.00 | 2.2 | 1.3 | 0.0 | 6.2 | 4.1 | 1.9 | 0.0 | 18.7 | 6.3 | 2.7 | 0.0 | 24.9 | 0.64 | 0.12 | 0.53 | 1.22 |
| 3 | 15.00 | 2.2 | 1.3 | 0.0 | 6.2 | 4.1 | 1.9 | 0.0 | 18.7 | 6.3 | 2.7 | 0.0 | 24.9 | 0.64 | 0.12 | 0.53 | 1.22 |
| 4 | 15.00 | 9.2 | 3.4 | 0.0 | 32.6 | 1.1 | 0.4 | 0.0 | 3.4 | 10.3 | 3.8 | 0.0 | 36.0 | 1.14 | 0.26 | 1.00 | 3.60 |

99 SUCCESSFUL MISSIONS

1 UNSUCCESSFUL MISSIONS

Figure 4-17 Push Button TAM Isolated Adjacent - Mission Summary

4.1.2.2 Test and Demonstration Results (Cont'd)

Table 4-3 Restated Mission Summary Report Values (No. 2)

| | Time Mission Completed (in seconds) Mean | Min. | Max. | Std. | Missions Successful | Unsuccessful |
|---|---|---|---|---|---|---|
| Bank-Remote | 17.5 | 0.0 | 93.7 | 14.51 | 67 | 33 |
| Adjacent | 12.0 | 0.0 | 38.9 | 6.19 | 88 | 12 |
| Isolated-Remote | 11.8 | 0.0 | 96.6 | 10.89 | 93 | 7 |
| Adjacent | 10.3 | 0.0 | 36.0 | 3.76 | 99 | 1 |

An isolated push button (or a bank of no more than three push buttons) which controls the CRT displays adjacent to the push button panel requires the minimum time and has a 99% success rate.

These newly determined values were used as parameter sets each time the IOS activity they described appeared in the preconstructed model of the RTP.

Prior to running the model of the RTP, time requirements for each leg had to be set. An experienced instructor pilot estimated the time requirements for each leg of the RTP and, further, the time necessary for the completion of each module in an RTP leg. Those tasks within the modules which were to be carried on throughout the duration of the module (i.e., cognitive, monitor intercom, make written notes) were assigned times equal to the estimated duration of the module. The time requirements for the other tasks were supplied by the TAMs. The IOS activities which differed from configuration #1 to #2 were identified. These were reading activities and accessing activities.

The identification was performed by stepping through the RTP in order to determine on which CRT a display was called. This was facilitated by the fact that stylized instruments can appear only on the right video display unit. Thus, if a second display was needed at the same time as the stylized instrument display, it had to be called on the left video display unit (LVDU).

Several standards were set to preserve consistency throughout the evaluation. The standards set for configuration #1 were:

4.1.2.2 Test and Demonstration Results (Cont'd)

(e) The LVDU was considered remote from the keyboard and the instructor position (Figure 4-1).

(f) The RVDU was considered adjacent to the keyboard and the instructor position.

(g) Both CRTs were considered adjacent to the one push button panel.

The modelling standards set for configuration #2 were:

(h) Both CRTs were considered adjacent to the keyboard and the instructor position (Figure 4-2).

(i) The LVDU was considered remote from the push button panel and the instructor position.

(j) The RVDU was considered adjacent to the panel and the instructor position.

In RTP 3, the tasks in which these differences are apparent, the parameter sets assigned are:

| #1 Parameter Set | Task | #2 Parameter Set |
|---|---|---|
| G | 1 | H |
| G | 2 | H |
| A | 43 | B |
| A | 37 | B |
| A | 50 | B |
| A | 27 | B |
| A | 121 | B |
| A | 43 | B |
| G | 6 | H |
| G | 7 | H |
| D | 68 | C |
| A | 69 | B |

A description of these tasks can be found in Appendix B by cross-referencing the task number with the ITD. A complete printout of the results of RTP leg 3, configurations #1 and #2, can be found in Appendix I.

The following parameters remained constant for #1 and #2 in RTP 3:

(k) Time allowed for mission : 1860 seconds

(l) Operator speed factor : 1.00

4.1.2.2 Test and Demonstration Results (Cont'd)

(m) Operator accuracy factor : 1.00

(n) Operator stress threshold : 2.50

The following tasks were initially declared dormant for #1 and #2:

| | | | |
|---|---|---|---|
| 77 | 41 | 103 | 101 |
| 78 | 49 | 105 | 102 |
| 80 | 52 | 110 | |
| 81 | 56 | 117 | |
| 83 | 26 | 67 | |
| 84 | 29 | 70 | |
| 86 | 33 | 71 | |
| 88 | 89 | 76 | |
| 42 | 92 | 95 | |
| 48 | 93 | 97 | |
| 34 | 94 | 100 | |

The results for #1 and #2 are shown in Figure 4-18 (see Appendix J for the full printout). The Mission Summary Report shows 65 successful missions for #1 as opposed to 78 for #2. The task summary report shows times of completion of leg 8 of the RTP to be:

Time Task Completed (in seconds)

| | Mean | Min. | Max. | Std. |
|---|---|---|---|---|
| #1 | 1846.7 | 1764.8 | 1927.2 | 30.20 |
| #2 | 1834.1 | 1762.6 | 1895.0 | 28.91 |

By changing the parameter sets of the tasks specified above from those of #1 to those of #2, an average of 12.6 seconds was saved from the average time necessary to complete leg 3 of the RTP. These 12.6 seconds made the difference of 13 more successful missions for #2. Stress levels were also lowered for the operators on #2 as a result of the new configuration. Table 4-4 shows a comparison of the stress levels of each operator on #1 and #2 (see paragraph 3.2.3.12 for operator identification).

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK NO | TASK TYPE | TASK ESS | ---COUNTERS--- REL | FAIL | SKIP | -----TIME TASK REALIZED---- MEAN | STD | MIN. | MAX | ----TIME TASK COMPLETED---- MEAN | STD. | MIN. | MAX. | ----TASK STRESS---- MEAN | STD. | MIN. | MAX. | -TASK COHESIVENESS- MEAN | STD. | MIN. | MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MULT | 1.00 | 140. | 40 | 0. | 67.7 | 11.65 | 58.8 | 114.3 | 84.0 | 11.84 | 65.8 | 129.2 | 1.01 | 0.01 | 1.00 | 1.04 | 0.00 | 0.00 | 0.00 | 0.01 |
| 2 | MULT | 1.00 | 127 | 27 | 0. | 88.5 | 15.26 | 65.8 | 132.8 | 104.5 | 15.82 | 76.2 | 148.4 | 1.01 | 0.01 | 1.00 | 1.04 | 0.00 | 0.00 | 0.00 | 0.01 |
| 3 | MULT | 1.00 | 100 | 0. | 0 | 931.5 | 17.67 | 903.4 | 1008.8 | 931.5 | 17.67 | 903.4 | 1008.8 | 1.00 | 0.01 | 1.00 | 1.07 | 0.00 | 0.00 | 0.00 | 0.02 |
| 4 | MULT | 1.00 | 103 | 3. | 0. | 656.0 | 10.29 | 636.7 | 683.8 | 671.4 | 12.77 | 649.0 | 703.9 | 1.01 | 0.01 | 1.00 | 1.03 | 0.00 | 0.00 | 0.00 | 0.01 |
| 5 | MULT | 1.00 | 108. | 8 | 0. | 958.7 | 18.23 | 929.7 | 1035.3 | 969.3 | 18.86 | 935.2 | 1043.2 | 1.02 | 0.02 | 1.00 | 1.11 | 0.00 | 0.01 | 0.00 | 0.03 |
| 6 | MULT | 1.00 | 136 | 36 | 0 | 975.0 | 22.50 | 935.2 | 1045.9 | 991.3 | 23.33 | 947.9 | 1062.0 | 1.02 | 0.02 | 1.00 | 1.11 | 0.00 | 0.01 | 0.00 | 0.03 |
| 7 | MULT | 1.00 | 148 | 48 | 0. | 1036.5 | 26.88 | 1009.4 | 1131.9 | 1068.7 | 28.23 | 1015.4 | 1149.1 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 8 | MULT | 1.00 | 100. | 0 | 0 | 1820.7 | 22.97 | 1771.5 | 1874.5 | 1846.7 | 30.20 | 1764.8 | 1927.2 | 3.58 | 0.33 | 3.50 | 5.00 | 2.31 | 0.52 | 2.19 | 4.57 |
| 26 | MULT | 1.00 | 200. | 0 | 0 | 572.8 | 227.48 | 317.7 | 874.1 | 572.8 | 227.48 | 317.7 | 874.1 | 1.33 | 0.30 | 1.01 | 1.79 | 0.00 | 0.00 | 0.00 | 0.00 |
| 27 | SING | 1.00 | 200. | 0 | 0. | 572.8 | 227.48 | 317.7 | 874.1 | 596.2 | 220.77 | 348.0 | 892.1 | 1.37 | 0.35 | 1.00 | 1.97 | 0.11 | 0.10 | 0.00 | 0.30 |
| 28 | SING | 1.00 | 200 | 0. | 0. | 572.8 | 227.48 | 317.7 | 874.1 | 619.8 | 216.34 | 377.1 | 907.2 | 1.22 | 0.20 | 1.00 | 1.55 | 0.06 | 0.06 | 0.00 | 0.16 |
| 29 | SING | 1.00 | 200. | 0 | 0 | 596.2 | 220.77 | 348.0 | 892.1 | 596.2 | 220.77 | 348.0 | 892.1 | 1.36 | 0.35 | 1.00 | 1.96 | 0.11 | 0.10 | 0.00 | 0.30 |
| 30 | SING | 1.00 | 200. | 0 | 0 | 596.2 | 220.77 | 348.0 | 892.1 | 619.5 | 214.05 | 377.7 | 909.1 | 1.36 | 0.35 | 1.00 | 1.96 | 0.11 | 0.10 | 0.00 | 0.30 |
| 31 | MULT | 1.00 | 200 | 0 | 0. | 572.8 | 227.48 | 317.7 | 874.1 | 618.0 | 214.45 | 376.9 | 906.5 | 1.34 | 0.32 | 1.00 | 1.91 | 0.10 | 0.10 | 0.00 | 0.28 |
| 32 | SING | 1.00 | 200 | 0 | 0. | 572.8 | 227.48 | 317.7 | 874.1 | 617.5 | 214.92 | 376.6 | 908.0 | 1.43 | 0.40 | 1.01 | 2.08 | 0.11 | 0.10 | 0.00 | 0.30 |
| 33 | MULT | 1.00 | 200 | 0. | 0. | 620.9 | 215.34 | 377.7 | 909.1 | 620.9 | 215.34 | 377.7 | 909.1 | 1.33 | 0.30 | 1.01 | 1.79 | 0.00 | 0.00 | 0.00 | 0.00 |
| 34 | MULT | 1.00 | 200 | 0 | 0 | 823.6 | 630.46 | 166.2 | 1502.4 | 823.6 | 630.46 | 166.2 | 1502.4 | 3.01 | 1.99 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 35 | SING | 1.00 | 200 | 0. | 0 | 823.6 | 630.46 | 166.2 | 1502.4 | 957.3 | 676.63 | [illegible] | 1679.5 | 3.01 | 2.00 | 1.00 | 5.00 | 2.28 | 2.29 | 0.00 | 4.57 |
| 36 | SING | 1.00 | 200 | 0 | 0. | 823.6 | 630.46 | 166.2 | 1502.4 | 838.7 | 615.34 | 196.0 | 1502.4 | 3.01 | 2.00 | 1.00 | 5.00 | 2.29 | 2.29 | 0.00 | 4.57 |
| 37 | SING | 1.00 | 200. | 0 | 0. | 838.7 | 615.34 | 196.0 | 1502.4 | 853.9 | 600.11 | 227.0 | 1502.4 | 3.01 | 2.00 | 1.00 | 5.00 | 2.29 | 2.29 | 0.00 | 4.57 |
| 38 | MULT | 1.00 | 200. | 0. | 0. | 823.6 | 630.46 | 166.2 | 1502.4 | 957.5 | 676.63 | 256.6 | 1683.9 | 3.01 | 2.00 | 1.00 | 5.00 | 2.29 | 2.29 | 0.00 | 4.57 |
| 39 | SING | 1.00 | 200. | 0. | 0. | 853.9 | 600.11 | 227.0 | 1502.4 | 900.0 | 616.02 | 256.8 | 1566.2 | 3.01 | 2.00 | 1.00 | 5.00 | 2.29 | 2.29 | 0.00 | 4.57 |
| 40 | SING | 1.00 | 200. | 0. | 0. | 823.6 | 630.46 | 166.2 | 1502.4 | 956.8 | 677.15 | 255.9 | 1686.9 | 3.01 | 1.99 | 1.00 | 5.00 | 2.29 | 2.29 | 0.00 | 4.57 |
| 41 | MULT | 1.00 | 200 | 0. | 0. | 960.0 | 676.09 | 256.8 | 1686.9 | 960.0 | 676.09 | 256.8 | 1686.9 | 3.01 | 1.99 | 1.01 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 42 | MULT | 1.00 | 400. | 0 | 0 | 620.6 | 349.28 | 76.2 | 1149.1 | 620.6 | 349.28 | 76.2 | 1149.1 | 1.77 | 0.69 | 1.00 | 3.38 | 0.00 | 0.00 | 0.00 | 0.00 |
| 43 | SING | 1.00 | 400. | 0. | 0. | 620.6 | 349.28 | 76.2 | 1149.1 | 652.0 | 358.26 | 106.2 | 1207.6 | 2.01 | 0.91 | 1.00 | 3.90 | 0.41 | 0.45 | 0.00 | 1.68 |
| 44 | SING | 1.00 | 400. | 0 | 0. | 620.6 | 349.28 | 76.2 | 1149.1 | 673.1 | 354.09 | 136.3 | 1246.1 | 1.69 | 0.69 | 1.00 | 3.13 | 0.27 | 0.32 | 0.00 | 1.18 |
| 45 | MULT | 1.00 | 400. | 0. | 0. | 620.6 | 349.28 | 76.2 | 1149.1 | 679.2 | 364.22 | 136.0 | 1269.3 | 1.93 | 0.86 | 1.00 | 3.72 | 0.37 | 0.42 | 0.00 | 1.56 |
| 46 | SING | 1.00 | 400. | 0. | 0. | 652.0 | 358.26 | 106.2 | 1207.6 | 713.5 | 378.61 | 166.2 | 1327.6 | 2.07 | 1.02 | 1.00 | 4.26 | 0.44 | 0.51 | 0.00 | 1.91 |
| 47 | SING | 1.00 | 400. | 0. | 0. | 620.6 | 349.28 | 76.2 | 1149.1 | 682.1 | 368.71 | 136.8 | 1270.0 | 2.14 | 1.05 | 1.00 | 4.38 | 0.41 | 0.45 | 0.00 | 1.68 |
| 48 | MULT | 1.00 | 400. | 0 | 0. | 713.5 | 378.61 | 166.2 | 1327.6 | 713.5 | 378.61 | 166.2 | 1327.6 | 2.12 | 1.24 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 49 | MULT | 1.00 | 400. | 0. | 0. | 745.2 | 350.22 | 256.8 | 1327.6 | 745.2 | 350.22 | 256.8 | 1327.6 | 2.03 | 1.15 | 1.01 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 50 | SING | 1.00 | 400. | 0 | 0 | 745.2 | 350.22 | 256.8 | 1327.6 | 757.0 | 341.49 | 287.6 | 1327.6 | 2.14 | 1.25 | 1.00 | 5.00 | 0.66 | 0.95 | 0.00 | 3.78 |
| 51 | SING | 1.00 | 400 | 0 | 0. | 745.2 | 350.22 | 256.8 | 1327.6 | 805.3 | 368.46 | 316.2 | 1446.6 | 1.79 | 0.91 | 1.00 | 4.01 | 0.45 | 0.67 | 0.00 | 2.68 |
| 52 | SING | 1.00 | 400 | 0. | 0 | 757.0 | 341.49 | 287.6 | 1327.6 | 757.0 | 341.49 | 287.6 | 1327.6 | 2.11 | 1.22 | 1.00 | 5.00 | 0.64 | 0.92 | 0.00 | 3.67 |
| 53 | MULT | 1.00 | 400 | 0 | 0. | 745.2 | 350.22 | 256.8 | 1327.6 | 807.7 | 373.49 | 316.7 | 1447.9 | 2.08 | 1.21 | 1.00 | 4.99 | 0.63 | 0.91 | 0.00 | 3.61 |
| 54 | SING | 1.00 | 400 | 0 | 0. | 757.0 | 341.49 | 287.6 | 1327.6 | 773.8 | 330.81 | 317.7 | 1327.6 | 2.11 | 1.22 | 1.00 | 5.00 | 0.64 | 0.92 | 0.00 | 3.67 |
| 55 | SING | 1.00 | 400. | 0. | 0 | 745.2 | 350.22 | 256.8 | 1327.6 | 806.7 | 374.21 | 315.9 | 1447.8 | 2.34 | 1.48 | 1.01 | 5.00 | 0.66 | 0.95 | 0.00 | 3.78 |
| 56 | MULT | 1.00 | 400 | 0 | 0. | 809.6 | 372.66 | 317.7 | 1447.9 | 809.6 | 372.66 | 317.7 | 1447.9 | 2.29 | 1.58 | 1.01 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 67 | MULT | 1.00 | 100. | 0 | 0. | 1634.1 | 22.36 | 1583.9 | 1686.9 | 1634.1 | 22.36 | 1583.9 | 1686.9 | 2.55 | 0.35 | 2.50 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 68 | MULT | 1.00 | 100. | 0 | 0. | 1634.1 | 22.36 | 1583.9 | 1686.9 | 1640.4 | 22.44 | 1589.8 | 1690.4 | 2.00 | 0.00 | 2.00 | 2.00 | 0.30 | 0.07 | 0.29 | 0.76 |
| 69 | SING | 1.00 | 100. | 0. | 0. | 1640.4 | 22.44 | 1589.8 | 1690.4 | 1657.7 | 22.42 | 1607.4 | 1707.1 | 2.00 | 0.00 | 2.00 | 2.00 | 0.30 | 0.07 | 0.29 | 0.76 |
| 70 | SING | 1.00 | 100. | 0. | 0. | 1657.7 | 22.42 | 1607.4 | 1707.1 | 1657.7 | 22.42 | 1607.4 | 1707.1 | 2.00 | 0.00 | 2.00 | 2.00 | 0.30 | 0.07 | 0.29 | 0.76 |
| 71 | SING | 1.00 | 100 | 0. | 0. | 1657.7 | 22.42 | 1607.4 | 1707.1 | 1657.7 | 22.42 | 1607.4 | 1707.1 | 2.00 | 0.00 | 2.00 | 2.00 | 0.30 | 0.07 | 0.29 | 0.76 |
| 72 | SING | 1.00 | 100 | 0. | 0. | 1657.7 | 22.42 | 1607.4 | 1707.1 | 1671.0 | 22.46 | 1621.4 | 1720.5 | 2.00 | 0.00 | 2.00 | 2.00 | 0.30 | 0.07 | 0.29 | 0.76 |
| 73 | MULT | 1.00 | 100. | 0. | 0. | 1634.1 | 22.36 | 1583.9 | 1686.9 | 1681.1 | 22.37 | 1630.9 | 1733.9 | 3.53 | 0.21 | 3.50 | 5.00 | 1.07 | 0.48 | 1.00 | 4.57 |
| 74 | MULT | 1.00 | 100. | 0. | 0. | 1671.0 | 22.46 | 1621.4 | 1720.5 | 1684.3 | 22.55 | 1634.9 | 1734.3 | 2.00 | 0.00 | 2.00 | 2.00 | 0.30 | 0.07 | 0.29 | 0.76 |
| 75 | SING | 1.00 | 100. | 0. | 0. | 1634.1 | 22.36 | 1583.9 | 1686.9 | 1682.2 | 22.43 | 1628.7 | 1735.2 | 3.53 | 0.21 | 3.50 | 5.00 | 1.07 | 0.48 | 1.00 | 4.57 |
| 76 | MULT | 1.00 | 100. | 0 | 0. | 1685.1 | 22.48 | 1634.9 | 1735.2 | 1685.1 | 22.48 | 1634.9 | 1735.2 | 2.50 | 0.00 | 2.50 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 77 | MULT | 1.00 | 100. | 0. | 0. | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 78 | MULT | 1.00 | 109. | 9. | 0. | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 79 | MULT | 1.00 | 100. | 0. | 0. | 0.0 | 0.00 | 0.0 | 0.0 | 31.1 | [illegible] | [illegible] | 32.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 80 | MULT | 1.00 | 107. | 7 | 0. | 31.0 | 0.95 | 28.9 | 32.6 | 31.0 | [illegible] | [illegible] | 32.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 81 | MULT | 1.00 | 100. | 0. | 0. | 31.1 | 0.95 | 28.9 | 32.6 | 31.1 | 0.95 | 28.9 | 32.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |

C & E ELECTRONICS LTD.

Figure 4-18 #1 Leg 3 (1 of 6)

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 82 | MULT | 1.00 | 100. | 0. | 0. | 31.1 | 0.95 | 28.9 | 32.6 | 61.1 | 1.21 | 58.8 | 64.7 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 83 | MULT | 1.00 | 100. | 0 | 0. | 31.1 | 0.95 | 28.9 | 32.6 | 31.1 | 0.95 | 28.9 | 32.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 84 | MULT | 1.00 | 104. | 4. | 0. | 31.1 | 0.96 | 28.9 | 32.6 | 31.1 | -0.96 | 28.9 | 32.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 85 | MULT | 1.00 | 100. | 0 | 0. | 31.1 | 0.95 | 28.9 | 32.6 | 47.1 | 7.64 | 30.9 | 67.0 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 86 | MULT | 1.00 | 100. | 0 | 0. | 47.1 | 7.64 | 30.9 | 67.0 | 47.1 | 7.64 | 30.9 | 67.0 | 1.00 | 0.00 | 1.00 | 1.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| 88 | MULT | 1.00 | 100. | 0 | 0. | 61.2 | 1.40 | 58.8 | 67.0 | 61.2 | 1.40 | 58.8 | 67.0 | 1.00 | 0.00 | 1.00 | 1.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| 89 | MULT | 1.00 | 300. | 0. | 0 | 987.1 | 529.69 | 377.7 | 1735.2 | 987.1 | 529.69 | 377.7 | 1735.2 | 2.58 | 1.74 | 1.01 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 90 | MULT | 1.00 | 300. | 0. | 0. | 987.1 | 529.69 | 377.7 | 1735.2 | 1056.8 | 559.70 | 437. | 1854.8 | 2.58 | 1.74 | 1.01 | 5.00 | 1.21 | 1.65 | 0.00 | 4.57 |
| 91 | MULT | 1.00 | 300. | 0 | 0. | 1056.8 | 559.70 | 437.1 | 1854.8 | 1065.9 | 563.67 | 445.1 | 1874.5 | 2.57 | 1.74 | 1.01 | 5.00 | 1.21 | 1.65 | 0.00 | 4.57 |
| 92 | MULT | 1.00 | 300 | 0 | 0. | 1055.9 | 563.67 | 445.1 | 1874.5 | 1065.9 | 563.67 | 445.1 | 1874.5 | 2.57 | 1.74 | 1.01 | 5.00 | 1.21 | 1.65 | 0.00 | 4.57 |
| 93 | MULT | 1.00 | 300. | 0. | 0. | 1065.9 | 563.67 | 445.1 | 1874.5 | 1065.9 | 563.67 | 445.1 | 1874.5 | 2.57 | 1.74 | 1.01 | 5.00 | 1.21 | 1.65 | 0.00 | 4.57 |
| 94 | MULT | 1.00 | 300. | 0 | 0. | 1065.9 | 563.67 | 445.1 | 1874.5 | 1065.9 | 563.67 | 445.1 | 1874.5 | 2.57 | 1.74 | 1.01 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 95 | MULT | 1.00 | 100. | 0. | 0 | 1367.0 | 31.24 | 1313.1 | 1447.9 | 1367.0 | 31.24 | 1313.1 | 1447.9 | 1.08 | 0.14 | 1.00 | 1.59 | 0.00 | 0.00 | 0.00 | 0.00 |
| 96 | MULT | 1.00 | 100. | 0 | 0. | 1367.0 | 31.24 | 1313.1 | 1447.9 | 1395.7 | 27.35 | 1343.3 | 1465.1 | 1.09 | 0.16 | 1.00 | 1.76 | 0.02 | 0.04 | 0.00 | 0.19 |
| 97 | MULT | 1.00 | 100. | 0 | 0. | 1395.7 | 27.35 | 1343.3 | 1455.1 | 1395.7 | 27.35 | 1343.3 | 1465.1 | 1.08 | 0.15 | 1.00 | 1.73 | 0.02 | 0.04 | 0.00 | 0.18 |
| 98 | SING | 1.00 | 100. | 0 | 0. | 1395.7 | 27.35 | 1343.3 | 1465.1 | 1450.7 | 20.58 | 1403.1 | 1497.6 | 1.08 | 0.17 | 1.00 | 1.80 | 0.02 | 0.05 | 0.00 | 0.23 |
| 99 | MULT | 1.00 | 100. | 0 | 0 | 1395.7 | 27.35 | 1343.3 | 1465.1 | 1451.9 | 22.35 | 1403.8 | 1502.4 | 1.05 | 0.08 | 1.00 | 1.37 | 0.01 | 0.02 | 0.00 | 0.11 |
| 100 | MULT | 1.00 | 100. | 0 | 0 | 1395.7 | 27.35 | 1343.3 | 1465.1 | 1395.7 | 27.35 | 1343.3 | 1465.1 | 1.10 | 0.18 | 1.00 | 1.84 | 0.02 | 0.05 | 0.00 | 0.23 |
| 101 | MULT | 1.00 | 100. | 0 | 0. | 1395.7 | 27.35 | 1343.3 | 1465.1 | 1395.7 | 27.35 | 1343.3 | 1465.1 | 1.10 | 0.18 | 1.00 | 1.84 | 0.02 | 0.05 | 0.00 | 0.23 |
| 102 | MULT | 1.00 | 100. | 0 | 0. | 1452.2 | 22.23 | 1403.8 | 1502.4 | 1452.2 | 22.23 | 1403.8 | 1502.4 | 1.45 | 0.25 | 1.04 | 2.22 | 0.00 | 0.00 | 0.00 | 0.00 |
| 103 | MULT | 1.00 | 300 | 0. | 0. | 769.5 | 212.09 | 445.1 | 1008.8 | 769.5 | 212.09 | 445.1 | 1008.8 | 1.49 | 0.33 | 1.01 | 1.98 | 0.00 | 0.00 | 0.00 | 0.00 |
| 104 | MULT | 1.00 | 300 | 0. | 0 | 769.5 | 212.09 | 445.1 | 1008.8 | 777.1 | 201.31 | 470.6 | 1008.8 | 1.60 | 0.41 | 1.01 | 2.28 | 0.15 | 0.10 | 0.00 | 0.35 |
| 105 | MULT | 1.00 | 300 | 0. | 0. | 777.1 | 201.31 | 470.6 | 1008.8 | 777.1 | 201.31 | 470.6 | 1008.8 | 1.47 | 0.32 | 1.01 | 2.04 | 0.09 | 0.06 | 0.00 | 0.24 |
| 106 | MULT | 1.00 | 300. | 0. | 0. | 777.1 | 201.31 | 470.6 | 1008.8 | 784.7 | 190.57 | 494.4 | 1008.8 | 1.60 | 0.41 | 1.01 | 2.28 | 0.16 | 0.11 | 0.00 | 0.37 |
| 107 | SING | 1.00 | 300. | 0 | 0. | 769.5 | 212.09 | 445.1 | 1008.8 | 786.4 | 207.54 | 468.3 | 1021.3 | 1.33 | 0.23 | 1.00 | 1.81 | 0.10 | 0.07 | 0.00 | 0.25 |
| 108 | MULT | 1.00 | 300. | 0. | 0. | 784.7 | 190.57 | 494.4 | 1008.8 | 801.0 | 185.84 | 518.1 | 1021.9 | 1.45 | 0.30 | 1.01 | 2.00 | 0.09 | 0.06 | 0.00 | 0.23 |
| 109 | MULT | 1.00 | 300. | 0. | 0. | 801.0 | 185.84 | 518.1 | 1021.9 | 817.2 | 181.17 | 541.6 | 1035.3 | 1.58 | 0.39 | 1.01 | 2.24 | 0.15 | 0.10 | 0.00 | 0.36 |
| 110 | MULT | 1.00 | 300. | 0 | 0. | 817.2 | 181.17 | 541.6 | 1035.3 | 817.2 | 181.17 | 541.6 | 1035.3 | 1.44 | 0.29 | 1.01 | 1.91 | 0.00 | 0.00 | 0.00 | 0.00 |
| 117 | MULT | 1.00 | 200. | 0 | 0. | 831.1 | 161.37 | 649.0 | 1062.0 | 831.1 | 161.37 | 649.0 | 1062.0 | 1.27 | 0.27 | 1.00 | 1.74 | 0.00 | 0.00 | 0.00 | 0.00 |
| 118 | MULT | 1.00 | 256 | 56. | 0. | 828.6 | 159.51 | 649.0 | 1071.1 | 841.7 | 155.50 | 661.5 | 1082.4 | 1.27 | 0.27 | 1.00 | 1.77 | 0.05 | 0.05 | 0.00 | 0.15 |
| 119 | MULT | 1.00 | 200. | 0. | 0. | 848.0 | 155.80 | 663.9 | 1082.4 | 856.4 | 164.15 | 663.9 | 1099.6 | 1.32 | 0.31 | 1.00 | 1.97 | 0.07 | 0.07 | 0.00 | 0.25 |
| 120 | MULT | 1.00 | 207. | 7. | 0. | 859.4 | 164.88 | 663.9 | 1099.6 | 859.4 | 164.88 | 663.9 | 1099.6 | 1.30 | 0.29 | 1.00 | 1.83 | 0.06 | 0.06 | 0.00 | 0.16 |
| 121 | MULT | 1.00 | 200. | 0 | 0. | 856.4 | 164.15 | 663.9 | 1099.6 | 880.1 | 157.28 | 694.8 | 1118.0 | 1.34 | 0.34 | 1.00 | 2.06 | 0.08 | 0.08 | 0.00 | 0.28 |
| 122 | MULT | 1.00 | 200. | 0 | 0. | 880.1 | 157.28 | 694.8 | 1118.0 | 892.5 | 152.04 | 719.1 | 1131.4 | 1.29 | 0.29 | 1.00 | 1.34 | 0.06 | 0.05 | 0.00 | 0.16 |

Figure 4-18 #1 Leg 3 (2 of 6)

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD. | BUSY TIME MIN. | BUSY TIME MAX | IDLE TIME MEAN | IDLE TIME STD. | IDLE TIME MIN. | IDLE TIME MAX. | TOTAL TIME USED MEAN | TOTAL TIME USED STD. | TOTAL TIME USED MIN. | TOTAL TIME USED MAX. | STRESS MEAN | STRESS STD. | STRESS MIN. | STRESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1860.00 | 1437.5 | 35.8 | 1362.8 | 1541.1 | 409.2 | 10.7 | 379.2 | 430.8 | 1846.7 | 30.2 | 1764.8 | 1927.2 | 2.05 | 0.04 | 1.99 | 2.22 |
| 2 | 1860.00 | 1452.8 | 39.6 | 1377.5 | 1564.5 | 393.9 | 14.5 | 354.6 | 418.4 | 1846.7 | 30.2 | 1764.8 | 1927.2 | 2.00 | 0.04 | 1.94 | 2.16 |
| 3 | 1860.00 | 1429.9 | 39.9 | 1354.7 | 1542.6 | 416.8 | 14.7 | 377.7 | 443.1 | 1846.7 | 30.2 | 1764.8 | 1927.2 | 1.99 | 0.04 | 1.92 | 2.14 |
| 4 | 1860.00 | 1622.7 | 33.9 | 1556.0 | 1724.7 | 224.0 | 10.7 | 196.9 | 244.2 | 1846.7 | 30.2 | 1764.8 | 1927.2 | 2.25 | 0.05 | 2.19 | 2.43 |
| 5 | 1860.00 | 994.6 | 8.8 | 975.0 | 1012.7 | 826.1 | 18.5 | 789.4 | 885.8 | 1820.7 | 23.0 | 1771.5 | 1874.5 | 1.82 | 0.06 | 1.72 | 1.98 |
| 6 | 1860.00 | 204.8 | 6.0 | 182.9 | 212.3 | 1615.9 | 28.0 | 1561.5 | 1691.6 | 1820.7 | 23.0 | 1771.5 | 1874.5 | 1.19 | 0.02 | 1.15 | 1.26 |
| 7 | 1860.00 | 204.8 | 6.0 | 182.9 | 212.3 | 1615.9 | 28.0 | 1561.5 | 1691.6 | 1820.7 | 23.0 | 1771.5 | 1874.5 | 1.19 | 0.02 | 1.15 | 1.26 |

65 SUCCESSFUL MISSIONS

35 UNSUCCESSFUL MISSIONS

Figure 4-18 #1 Leg 3 (3 of 6)

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK | TASK | TASK | ---COUNTERS--- | | | -----TIME TASK REALIZED---- | | | | ----TIME TASK COMPLETED---- | | | | ----TASK STRESS---- | | | | -TASK COHESIVENESS- | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NO | TYPE | ESS | REL. | FAIL | SKIP | MEAN | STD. | MIN. | MAX | MEAN | STD. | MIN | MAX | MEAN | STD | MIN. | MAX. | MEAN | STD. | MIN. | MAX. |
| 1 | MULT | 1.00 | 106. | 6. | 0. | 62.0 | 4.41 | 58.2 | 84.9 | 77.7 | 8.00 | 61.1 | 107.9 | 1.00 | 0.00 | 1.00 | 1.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | MULT | 1.00 | 101 | 1 | 0. | 77.9 | 8.60 | 61.1 | 107.9 | 94.9 | 11.87 | 68.1 | 127.0 | 1.00 | 0.00 | 1.00 | 1.02 | 0.00 | 0.00 | 0.00 | 0.00 |
| 3 | MULT | 1.00 | 100 | 0 | 0. | 925.5 | 14.99 | 898.0 | 967.0 | 925.5 | 14.89 | 898.0 | 967.0 | 1.00 | 0.00 | 1.00 | 1.02 | 0.00 | 0.00 | 0.00 | 0.01 |
| 4 | MULT | 1.00 | 102. | 2. | 0 | 650.3 | 7.41 | 633.3 | 666.3 | 666.2 | 10.59 | 643.2 | 691.3 | 1.00 | 0.00 | 1.00 | 1.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5 | MULT | 1.00 | 116. | 16. | 0. | 952.7 | 14.88 | 924.0 | 993.7 | 965.0 | 16.97 | 931.6 | 1013.0 | 1.01 | 0.01 | 1.00 | 1.06 | 0.00 | 0.00 | 0.00 | 0.02 |
| 6 | MULT | 1.00 | 101 | 1 | 0 | 966.0 | 18.20 | 931.6 | 1013.0 | 981.2 | 18.89 | 942.3 | 1032.7 | 1.01 | 0.01 | 1.00 | 1.06 | 0.00 | 0.00 | 0.00 | 0.02 |
| 7 | MULT | 1.00 | 105 | 5. | 0. | 1038.9 | 18.15 | 1000.6 | 1085.8 | 1050.3 | 18.54 | 1012.9 | 1097.9 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 8 | MULT | 1.00 | 100 | 0. | 0. | 1810.1 | 20.74 | 1760.3 | 1850.4 | 1834.1 | 28.91 | 1762.6 | 1895.0 | 3.50 | 0.00 | 3.50 | 3.50 | 2.19 | 0.00 | 2.19 | 2.19 |
| 26 | MULT | 1.00 | 200. | 0 | 0 | 565.4 | 228.76 | 314.6 | 834.5 | 565.4 | 228.76 | 314.6 | 834.5 | 1.31 | 0.29 | 1.00 | 1.69 | 0.00 | 0.00 | 0.00 | 0.00 |
| 27 | SING | 1.00 | 200. | 0. | 0. | 565.4 | 228.76 | 314.6 | 834.5 | 588.7 | 221.91 | 345.4 | 850.6 | 1.35 | 0.34 | 1.00 | 1.82 | 0.10 | 0.10 | 0.00 | 0.25 |
| 28 | SING | 1.00 | 200. | 0. | 0. | 565.4 | 228.76 | 314.6 | 834.5 | 612.8 | 217.45 | 374.2 | 869.3 | 1.21 | 0.20 | 1.00 | 1.46 | 0.06 | 0.06 | 0.00 | 0.13 |
| 29 | SING | 1.00 | 200. | 0 | 0. | 588.7 | 221.91 | 345.4 | 850.6 | 588.7 | 221.91 | 345.4 | 850.6 | 1.35 | 0.34 | 1.00 | 1.81 | 0.10 | 0.10 | 0.00 | 0.24 |
| 30 | SING | 1.00 | 200 | 0. | 0. | 588.7 | 221.91 | 345.4 | 850.6 | 612.3 | 215.07 | 375.4 | 868.0 | 1.35 | 0.34 | 1.00 | 1.81 | 0.10 | 0.10 | 0.00 | 0.24 |
| 31 | MULT | 1.00 | 200. | 0. | 0. | 565.4 | 228.76 | 314.6 | 834.5 | 610.9 | 215.47 | 374.5 | 866.6 | 1.33 | 0.32 | 1.00 | 1.76 | 0.10 | 0.09 | 0.00 | 0.23 |
| 32 | SING | 1.00 | 200. | 0. | 0. | 565.4 | 228.76 | 314.6 | 834.5 | 610.4 | 215.70 | 374.6 | 867.1 | 1.41 | 0.39 | 1.00 | 1.93 | 0.10 | 0.10 | 0.00 | 0.25 |
| 33 | MULT | 1.00 | 200 | 0 | 0. | 613.8 | 216.47 | 375.4 | 869.3 | 613.8 | 216.47 | 375.4 | 869.3 | 1.31 | 0.29 | 1.00 | 1.69 | 0.00 | 0.00 | 0.00 | 0.00 |
| 34 | MULT | 1.00 | 200 | 0 | 0 | 811.5 | 627.65 | 158.3 | 1478.1 | 811.5 | 627.65 | 158.3 | 1478.1 | 3.01 | 2.00 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 35 | SING | 1.00 | 200. | 0. | 0 | 811.5 | 627.65 | 158.3 | 1478.1 | 945.9 | 673.75 | 247.3 | 1657.8 | 3.01 | 2.00 | 1.00 | 5.00 | 2.27 | 2.27 | 0.00 | 4.57 |
| 36 | SING | 1.00 | 200. | 0. | 0. | 811.5 | 627.65 | 158.3 | 1478.1 | 826.7 | 612.37 | 189.9 | 1478.1 | 3.01 | 2.00 | 1.00 | 5.00 | 2.29 | 2.27 | 0.00 | 4.57 |
| 37 | SING | 1.00 | 200 | 0. | 0. | 826.7 | 612.37 | 189.9 | 1478.1 | 841.9 | 597.14 | 220.0 | 1478.1 | 3.01 | 2.00 | 1.00 | 5.00 | 2.29 | 2.29 | 0.00 | 4.57 |
| 39 | MULT | 1.00 | 200 | 0. | 0 | 811.5 | 627.65 | 158.3 | 1478.1 | 945.6 | 673.53 | 247.1 | 1654.2 | 3.01 | 2.00 | 1.00 | 5.00 | 2.29 | 2.29 | 0.00 | 4.57 |
| 39 | SING | 1.00 | 200 | 0. | 0 | 841.9 | 597.14 | 220.0 | 1478.1 | 888.0 | 612.99 | 252.5 | 1544.4 | 3.01 | 2.00 | 1.00 | 5.00 | 2.29 | 2.29 | 0.00 | 4.57 |
| 40 | SING | 1.00 | 200 | 0. | 0 | 811.5 | 627.65 | 158.3 | 1478.1 | 945.3 | 673.88 | 248.4 | 1655.3 | 3.01 | 2.00 | 1.00 | 5.00 | 2.29 | 2.29 | 0.00 | 4.57 |
| 41 | MULT | 1.00 | 200 | 0 | 0. | 948.1 | 673.11 | 252.5 | 1657.8 | 948.1 | 673.11 | 252.5 | 1657.8 | 3.01 | 2.00 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 42 | MULT | 1.00 | 400 | 0 | 0 | 611.2 | 347.13 | 68.1 | 1097.9 | 611.2 | 347.13 | 68.1 | 1097.9 | 1.74 | 0.65 | 1.00 | 3.02 | 0.00 | 0.00 | 0.00 | 0.00 |
| 43 | SING | 1.00 | 400 | 0 | 0. | 611.2 | 347.13 | 68.1 | 1097.9 | 641.9 | 355.04 | 98.3 | 1164.7 | 1.97 | 0.88 | 1.00 | 3.59 | 0.38 | 0.41 | 0.00 | 1.30 |
| 44 | SING | 1.00 | 400 | 0. | 0 | 611.2 | 347.13 | 68.1 | 1097.9 | 663.0 | 350.39 | 128.1 | 1181.8 | 1.66 | 0.66 | 1.00 | 2.91 | 0.25 | 0.29 | 0.00 | 0.91 |
| 45 | MULT | 1.00 | 400 | 0 | 0 | 611.2 | 347.13 | 68.1 | 1097.9 | 668.9 | 360.21 | 128.2 | 1213.5 | 1.90 | 0.83 | 1.00 | 3.43 | 0.35 | 0.38 | 0.00 | 1.21 |
| 46 | SING | 1.00 | 400. | 0 | 0 | 641.9 | 355.04 | 98.3 | 1164.7 | 703.2 | 374.67 | 158.3 | 1283.5 | 2.03 | 0.97 | 1.00 | 3.92 | 0.4[illegible] | 0.46 | 0.00 | 1.49 |
| 47 | SING | 1.00 | 400 | 0. | 0 | 611.2 | 347.13 | 68.1 | 1097.9 | 672.7 | 365.96 | 128.1 | 1216.8 | 2.09 | 0.99 | 1.00 | 4.02 | 0.38 | 0.41 | 0.00 | 1.30 |
| 48 | MULT | 1.00 | 400. | 0 | 0. | 703.2 | 374.67 | 158.3 | 1283.5 | 703.2 | 374.67 | 158.3 | 1283.5 | 2.05 | 1.14 | 1.00 | 4.66 | 0.00 | 0.00 | 0.00 | 0.00 |
| 49 | MULT | 1.00 | 400 | 0 | 0. | 735.1 | 346.01 | 252.5 | 1283.5 | 735.1 | 346.01 | 252.5 | 1283.5 | 1.96 | 1.04 | 1.00 | 4.37 | 0.00 | 0.00 | 0.00 | 0.00 |
| 50 | SING | 1.00 | 400 | 0 | 0 | 735.1 | 346.01 | 252.5 | 1283.5 | 746.9 | 337.18 | 283.1 | 1283.5 | 2.08 | 1.17 | 1.00 | 4.55 | 0.58 | 0.80 | 0.00 | 2.77 |
| 51 | SING | 1.00 | 400. | 0. | 0. | 735.1 | 346.01 | 252.5 | 1283.5 | 794.0 | 361.50 | 312.5 | 1402.8 | 1.75 | 0.85 | 1.00 | 3.58 | 0.40 | 0.56 | 0.00 | 1.95 |
| 52 | SING | 1.00 | 400 | 0. | 0 | 746.9 | 337.18 | 283.1 | 1283.5 | 746.9 | 337.18 | 283.1 | 1283.5 | 2.05 | 1.14 | 1.00 | 4.45 | 0.56 | 0.78 | 0.00 | 2.68 |
| 53 | MULT | 1.00 | 400. | 0. | 0. | 735.1 | 346.01 | 252.5 | 1283.5 | 797.8 | 368.79 | 312.6 | 1402.5 | 2.02 | 1.13 | 1.00 | 4.41 | 0.55 | 0.77 | 0.00 | 2.64 |
| 54 | SING | 1.00 | 400 | 0 | 0 | 746.9 | 337.18 | 283.1 | 1283.5 | 763.7 | 326.49 | 314.6 | 1283.5 | 2.05 | 1.14 | 1.00 | 4.45 | 0.56 | 0.78 | 0.00 | 2.68 |
| 55 | SING | 1.00 | 400. | 0 | 0 | 735.1 | 346.01 | 252.5 | 1283.5 | 796.9 | 369.41 | 312.4 | 1403.7 | 2.30 | 1.43 | 1.00 | 5.00 | 0.58 | 0.80 | 0.00 | 2.77 |
| 56 | MULT | 1.00 | 400 | 0 | 0 | 799.5 | 368.07 | 314.6 | 1403.7 | 799.5 | 368.07 | 314.6 | 1403.7 | 2.27 | 1.56 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 67 | MULT | 1.00 | 100. | 0. | 0. | 1619.3 | 20.01 | 1574.3 | 1657.8 | 1619.3 | 20.01 | 1574.3 | 1657.8 | 2.78 | 0.79 | 2.50 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 68 | MULT | 1.00 | 100 | 0 | 0 | 1619.3 | 20.01 | 1574.3 | 1657.8 | 1630.0 | 20.71 | 1585.5 | 1672.5 | 2.00 | 0.00 | 2.00 | 2.00 | 0.34 | 0.15 | 0.29 | 0.76 |
| 69 | SING | 1.00 | 100 | 0. | 0. | 1630.0 | 20.71 | 1585.5 | 1672.5 | 1647.2 | 20.76 | 1602.2 | 1689.1 | 2.00 | 0.00 | 2.00 | 2.00 | 0.34 | 0.15 | 0.29 | 0.76 |
| 70 | SING | 1.00 | 100 | 0 | 0. | 1647.2 | 20.76 | 1602.2 | 1687.1 | 1647.2 | 20.76 | 1602.2 | 1689.1 | 2.00 | 0.00 | 2.00 | 2.00 | 0.34 | 0.15 | 0.29 | 0.76 |
| 71 | SING | 1.00 | 100. | 0 | 0. | 1647.2 | 20.76 | 1602.2 | 1689.1 | 1647.2 | 20.76 | 1602.2 | 1689.1 | 2.00 | 0.00 | 2.00 | 2.00 | 0.34 | 0.15 | 0.29 | 0.76 |
| 72 | SING | 1.00 | 100 | 0 | 0. | 1647.2 | 20.76 | 1602.2 | 1689.1 | 1660.5 | 20.77 | 1615.1 | 1703.6 | 2.00 | 0.00 | 2.00 | 2.00 | 0.34 | 0.15 | 0.29 | 0.76 |
| 73 | MULT | 1.00 | 100 | 0 | 0 | 1619.3 | 20.01 | 1574.3 | 1657.8 | 1666.1 | 20.47 | 1607.0 | 1704.8 | 3.61 | 0.41 | 2.79 | 5.00 | 1.30 | 0.93 | 1.00 | 4.57 |
| 74 | MULT | 1.00 | 100 | 0 | 0. | 1660.5 | 20.77 | 1615.1 | 1703.6 | 1673.8 | 20.83 | 1627.9 | 1716.7 | 2.00 | 0.00 | 2.00 | 2.00 | 0.34 | 0.15 | 0.29 | 0.76 |
| 75 | SING | 1.00 | 100. | 0 | 0. | 1619.3 | 20.01 | 1574.3 | 1657.8 | 1666.9 | 20.17 | 1625.1 | 1707.6 | 3.66 | 0.47 | 3.50 | 5.00 | 1.30 | 0.93 | 1.00 | 4.57 |
| 76 | MULT | 1.00 | 100 | 0 | 0 | 1674.7 | 20.78 | 1627.9 | 1716.7 | 1674.7 | 20.78 | 1627.9 | 1716.7 | 2.50 | 0.00 | 2.50 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 77 | MULT | 1.00 | 100. | 0 | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 78 | MULT | 1.00 | 106. | 6 | 0. | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 79 | MULT | 1.00 | 100. | 0 | 0. | 0.0 | 0.00 | 0.0 | 0.0 | 30.9 | [illegible] | [illegible] | 32.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 80 | MULT | 1.00 | 108 | 8. | 0. | 30.9 | 0.93 | 28.4 | 32.6 | 30.9 | [illegible] | [illegible] | 32.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | MULT | 1.00 | 100. | 0. | 0. | 30.9 | 0.95 | 28.4 | 32.6 | 30.9 | 0.95 | 28.4 | 32.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |

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Figure 4-18 #2 Leg 3 (4 of 6)

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 82 | MULT | 1.00 | 100. | 0. | 0. | 30.9 | 0.95 | 28.4 | 32.6 | 61.0 | 1.15 | 58.2 | 64.2 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 83 | MULT | 1.00 | 100. | 0. | 0. | 30.9 | 0.95 | 28.4 | 32.6 | 30.9 | 0.95 | 28.4 | 32.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 84 | MULT | 1.00 | 105. | 5. | 0. | 30.9 | 0.94 | 28.4 | 32.6 | 30.9 | 0.94 | 28.4 | 32.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 85 | MULT | 1.00 | 100. | 0. | 0. | 30.9 | 0.95 | 28.4 | 32.6 | 45.8 | 7.07 | 30.5 | 63.7 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 86 | MULT | 1.00 | 100 | 0. | 0. | 45.8 | 7.07 | 30.5 | 63.7 | 45.8 | 7.07 | 30.5 | 63.7 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 88 | MULT | 1.00 | 100 | 0. | 0. | 61.0 | 1.18 | 58.2 | 64.2 | 61.0 | 1.18 | 58.2 | 64.2 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 89 | MULT | 1.00 | 300. | 0. | 0 | 978.8 | 528.58 | 375.4 | 1716.7 | 978.8 | 528.58 | 375.4 | 1716.7 | 2.57 | 1.74 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 90 | MULT | 1.00 | 300. | 0. | 0. | 978.9 | 528.58 | 375.4 | 1716.7 | 1048.8 | 558.17 | 435.2 | 1836.6 | 2.57 | 1.74 | 1.00 | 5.00 | 1.14 | 1.54 | 0.00 | 4.26 |
| 91 | MULT | 1.00 | 300. | 0 | 0 | 1048.8 | 558.17 | 435.2 | 1836.6 | 1057.8 | 562.11 | 441.3 | 1850.4 | 2.56 | 1.75 | 1.00 | 5.00 | 1.14 | 1.54 | 0.00 | 4.26 |
| 92 | MULT | 1.00 | 300. | 0. | 0. | 1057.8 | 562.11 | 441.3 | 1850.4 | 1057.8 | 562.11 | 441.3 | 1850.4 | 2.56 | 1.75 | 1.00 | 5.00 | 1.14 | 1.54 | 0.00 | 4.26 |
| 93 | MULT | 1.00 | 300. | 0. | 0. | 1057.8 | 562.11 | 441.3 | 1850.4 | 1057.8 | 562.11 | 441.3 | 1850.4 | 2.56 | 1.75 | 1.00 | 5.00 | 1.14 | 1.54 | 0.00 | 4.26 |
| 94 | MULT | 1.00 | 300 | 0. | 0 | 1057.8 | 562.11 | 441.3 | 1850.4 | 1057.8 | 562.11 | 441.3 | 1850.4 | 2.56 | 1.75 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 95 | MULT | 1.00 | 100. | 0. | 0. | 1347.1 | 22.42 | 1301.2 | 1403.7 | 1347.1 | 22.42 | 1301.2 | 1403.7 | 1.01 | 0.04 | 1.00 | 1.21 | 0.00 | 0.00 | 0.00 | 0.00 |
| 96 | MULT | 1.00 | 100. | 0 | 0. | 1347.1 | 22.42 | 1301.2 | 1403.7 | 1377.8 | 21.20 | 1333.4 | 1427.2 | 1.01 | 0.04 | 1.00 | 1.21 | 0.00 | 0.01 | 0.00 | 0.04 |
| 97 | MULT | 1.00 | 100. | 0 | 0. | 1377.8 | 21.20 | 1333.4 | 1427.2 | 1377.9 | 21.20 | 1333.4 | 1427.2 | 1.01 | 0.04 | 1.00 | 1.19 | 0.00 | 0.01 | 0.00 | 0.04 |
| 98 | SING | 1.00 | 100. | 0. | 0. | 1377.8 | 21.20 | 1333.4 | 1427.2 | 1436.9 | 19.60 | 1393.0 | 1470.9 | 1.01 | 0.03 | 1.00 | 1.22 | 0.00 | 0.01 | 0.00 | 0.06 |
| 99 | MULT | 1.00 | 100 | 0. | 0. | 1377.8 | 21.20 | 1333.4 | 1427.2 | 1436.9 | 20.04 | 1393.4 | 1478.1 | 1.01 | 0.02 | 1.00 | 1.13 | 0.00 | 0.01 | 0.00 | 0.04 |
| 100 | MULT | 1.00 | 100. | 0 | 0. | 1377.8 | 21.20 | 1333.4 | 1427.2 | 1377.8 | 21.20 | 1333.4 | 1427.2 | 1.01 | 0.04 | 1.00 | 1.26 | 0.00 | 0.01 | 0.00 | 0.06 |
| 101 | MULT | 1.00 | 100. | 0. | 0. | 1377.8 | 21.20 | 1333.4 | 1427.2 | 1377.8 | -21.20 | 1333.4 | 1427.2 | 1.01 | 0.04 | 1.00 | 1.26 | 0.00 | 0.01 | 0.00 | 0.06 |
| 102 | MULT | 1.00 | 100 | 0. | 0. | 1437.3 | 19.97 | 1393.4 | 1478.1 | 1437.3 | 19.97 | 1393.4 | 1478.1 | 1.30 | 0.17 | 1.00 | 1.74 | 0.00 | 0.00 | 0.00 | 0.00 |
| 103 | MULT | 1.00 | 300. | 0. | 0. | 763.0 | 212.66 | 441.3 | 967.0 | 763.0 | 212.66 | 441.3 | 967.0 | 1.47 | 0.32 | 1.00 | 1.85 | 0.00 | 0.00 | 0.00 | 0.00 |
| 104 | MULT | 1.00 | 300. | 0. | 0. | 763.0 | 212.66 | 441.3 | 967.0 | 770.7 | 201.71 | 466.5 | 967.0 | 1.58 | 0.40 | 1.00 | 2.07 | 0.14 | 0.10 | 0.00 | 0.28 |
| 105 | MULT | 1.00 | 300. | 0. | 0. | 770.7 | 201.71 | 466.5 | 967.0 | 770.7 | 201.71 | 466.5 | 967.0 | 1.45 | 0.31 | 1.00 | 1.86 | 0.09 | 0.06 | 0.00 | 0.18 |
| 106 | MULT | 1.00 | 300. | 0. | 0. | 770.7 | 201.71 | 466.5 | 967.0 | 778.4 | 190.82 | 490.7 | 967.0 | 1.58 | 0.40 | 1.00 | 2.08 | 0.15 | 0.10 | 0.00 | 0.29 |
| 107 | SING | 1.00 | 300. | 0. | 0. | 763.0 | 212.66 | 441.3 | 967.0 | 780.0 | 208.04 | 466.3 | 980.0 | 1.32 | 0.22 | 1.00 | 1.64 | 0.09 | 0.06 | 0.00 | 0.19 |
| 108 | MULT | 1.00 | 300. | 0. | 0. | 778.4 | 190.82 | 490.7 | 967.0 | 794.8 | 185.90 | 514.5 | 980.4 | 1.43 | 0.29 | 1.00 | 1.82 | 0.08 | 0.06 | 0.00 | 0.17 |
| 109 | MULT | 1.00 | 300. | 0 | 0. | 794.8 | 185.90 | 514.5 | 980.4 | 811.1 | 180.99 | 538.4 | 993.7 | 1.55 | 0.38 | 1.00 | 2.04 | 0.14 | 0.10 | 0.00 | 0.28 |
| 110 | MULT | 1.00 | 300. | 0. | 0. | 811.1 | 180.99 | 538.4 | 993.7 | 811.1 | 180.99 | 538.4 | 993.7 | 1.42 | 0.29 | 1.00 | 1.77 | 0.00 | 0.00 | 0.00 | 0.00 |
| 117 | MULT | 1.00 | 200. | 0. | 0. | 823.6 | 158.42 | 643.2 | 1032.7 | 823.6 | 158.42 | 643.2 | 1032.7 | 1.26 | 0.26 | 1.00 | 1.65 | 0.00 | 0.00 | 0.00 | 0.00 |
| 118 | MULT | 1.00 | 255. | 55. | 0. | 819.9 | 156.55 | 643.2 | 1032.7 | 832.7 | 152.72 | 655.7 | 1039.5 | 1.25 | 0.26 | 1.00 | 1.65 | 0.05 | 0.05 | 0.00 | 0.12 |
| 119 | MULT | 1.00 | 200. | 0 | 0. | 839.9 | 152.98 | 659.8 | 1039.5 | 848.5 | 161.45 | 659.8 | 1056.4 | 1.29 | 0.29 | 1.00 | 1.76 | 0.06 | 0.06 | 0.00 | 0.18 |
| 120 | MULT | 1.00 | 206. | 6. | 0. | 849.8 | 161.37 | 659.8 | 1056.4 | 849.8 | 161.37 | 659.8 | 1056.4 | 1.28 | 0.27 | 1.00 | 1.68 | 0.05 | 0.05 | 0.00 | 0.13 |
| 121 | MULT | 1.00 | 200. | 0. | 0. | 848.5 | 161.45 | 659.8 | 1056.4 | 872.2 | 154.51 | 690.5 | 1073.4 | 1.31 | 0.32 | 1.00 | 1.83 | 0.07 | 0.07 | 0.00 | 0.20 |
| 122 | MULT | 1.00 | 200. | 0. | 0. | 872.2 | 154.51 | 690.5 | 1073.4 | 890.8 | 149.24 | 714.4 | 1085.8 | 1.27 | 0.27 | 1.00 | 1.68 | 0.05 | 0.05 | 0.00 | 0.13 |

Figure 4-18 #2 Leg 3 (5 of 6)

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME | | | | IDLE TIME | | | | TOTAL TIME USED | | | | STRESS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MEAN | STD | MIN. | MAX. | MEAN | STD. | MIN. | MAX. | MEAN | STD. | MIN. | MAX. | MEAN | STD | MIN. | MAX. |
| 1 | 1860.00 | 1419.6 | 29.5 | 1348.0 | 1489 3 | 414.5 | 8.6 | 394.7 | 430.7 | 1834.1 | 28.9 | 1762 6 | 1895.0 | 2.02 | 0.02 | 1.96 | 2.09 |
| 2 | 1850 00 | 1436.4 | 30.4 | 1374 4 | 1511 8 | 397 7 | 9.4 | 372.9 | 419 9 | 1834.1 | 28.9 | 1762 6 | 1895.0 | 1.98 | 0.02 | 1.90 | 2.04 |
| 3 | 1860.00 | 1413.1 | 30.6 | 1350.7 | 1489.9 | 421.0 | 9.6 | 394.9 | 442.8 | 1834.1 | 28.9 | 1762.6 | 1895.0 | 1.96 | 0.02 | 1.88 | 2.02 |
| 4 | 1860.00 | 1606.6 | 27.9 | 1542.0 | 1668.9 | 227.6 | 11.9 | 201.6 | 256.1 | 1834.1 | 28.9 | 1762.6 | 1895.0 | 2 23 | 0.02 | 2.20 | 2.29 |
| 5 | 1860.00 | 993.5 | 9 6 | 966.5 | 1014.6 | 816.6 | 14.1 | 785.2 | 849.7 | 1810.1 | 20.7 | 1760.3 | 1850.4 | 1.79 | 0.04 | 1.63 | 1.90 |
| 6 | 1860.00 | 208.2 | 2.9 | 196.2 | 213.1 | 1601.9 | 21.2 | 1559.4 | 1646.8 | 1810.1 | 20.7 | 1760.3 | 1850.4 | 1.18 | 0.02 | 1.13 | 1.25 |
| 7 | 1860.00 | 208.2 | 2.9 | 196 2 | 213.1 | 1601.9 | 21.2 | 1559 4 | 1646.8 | 1810.1 | 20.7 | 1760.3 | 1850.4 | 1.18 | 0.02 | 1.13 | 1.25 |

78 SUCCESSFUL MISSIONS

22 UNSUCCESSFUL MISSIONS

Figure 4-18 #2 Leg 3 (6 of 6)

4.1.2.2 Test and Demonstration Results (Cont'd)

Table 4-4 Comparative Stress Levels (Leg 3)

| #1 Mean Stress | Operator Number | #2 Mean Stress | ΔStress |
|---|---|---|---|
| 2.05 | 1 | 2.02 | 0.03 |
| 2.00 | 2 | 1.98 | 0.02 |
| 1.99 | 3 | 1.96 | 0.03 |
| 2.25 | 4 | 2.23 | 0.02 |
| 1.82 | 5 | 1.79 | 0.03 |
| 1.19 | 6 | 1.18 | 0.01 |
| 1.19 | 7 | 1.18 | 0.01 |

As can be seen from the ΔStress column, the greatest decreases in stress affected operators 1, 3, and 5 (visual, right manual, audio). The results can be explained by analyzing the difference between #1 and #2. The difference lay in the placement of the two CRTs and the panel. Thus, the two adjacent CRT configuration (#2) was better suited to the lesson presented here.

The visual operator on #2 had less head and eye movement to perform, and the cumulative effect of this lowered the stress level on that operator.

Operator 3 (right manual) also had less stress in the #2 configuration. The amount of time operator 3 was idle, while operator 1 looked to a remote display (#1), decreased on #2. As a result, less time was taken from the total time allowed operator 3, keeping the stress level down. Operators 2, 4, 5, 6, 7 (left manual, cognitive, audio, verbal, pedal) also experienced lower stress. Because none of the tasks involving these operators differed from #1 and #2, the lowering of the stress here is explained as follows: the decreased stress on operators 1 and 3 lowered the disorganizing influence these two operators had on the other factors. As a result, the stress levels on the other operators decreased. Conclusions drawn from these results will follow the presentation of data from the other legs of the RTP.

In RTP 4, the tasks in which the differences between #1 and #2 are apparent, the parameter sets assigned to them are:

4.1.2.2 Test and Demonstration Results (Cont'd)

| #1 Parameter Set | Task | #2 Parameter Set |
|---|---|---|
| D | 1 | C |
| G | 112 | H |
| G | 113 | H |
| G | 114 | H |
| D | 86 | C |
| G | 3 | H |
| A | 62 | B |
| A | 43 | B |
| F | 4 | E |
| G | 5 | H |
| A | 43 | B |

The following parameters remained constant for #1 and #2 in RTP 4:

Time allowed for mission : 1600 seconds

Operator speed factor : 1.0

Operator accuracy factor : 1.0

Operator stress threshold : 2.5

The following tasks were initially declared dormant for #1 and #2, either because they were not needed, or because they did not apply to the jet trainer configurations:

| | | |
|---|---|---|
| 111 | 60 | 88 |
| 115 | 66 | 89 |
| 116 | 77 | 90 |
| 42 | 78 | 92 |
| 48 | 79 | 93 |
| 49 | 80 | 94 |
| 50 | 81 | 95 |
| 52 | 83 | 97 |
| 54 | 84 | 100 |
| 56 | 85 | 101 |
| 57 | 86 | 102 |

4.1.2.2 Test and Demonstration Results (Cont'd)

SAINT's results for running #1 and #2 are shown in Figure 4-19.

The Mission Summary Reports show 86 successful missions for #1 as opposed to 92 successes for #2. The task summary report shows the times of completions for leg 4 of the RTP to be:

Time Mission Completed (in seconds)

| | Mean | Min. | Max. | Std. |
|---|---|---|---|---|
| #1 | 1415.7 | 1261.3 | 2032.2 | 185.44 |
| #2 | 1373.9 | 1249.6 | 2030.7 | 157.78 |

By using the parameter sets for #2 instead of #1 in the tasks specified above, the average time necessary to complete leg 4 of the RTP was reduced by 41.8 seconds. These 41.8 seconds were responsible for the six extra successes on #2 and also for the reduction of the stress levels encountered by the operators.

The new configuration (#2) was instrumental in lowering the stress on the operators. Table 4-5 shows a comparison of the stress levels of each operator on #1 and #2.

Table 4-5 Comparative Stress Levels (Leg 4)

| #1 Mean Stress | Operator Number | #2 Mean Stress | ΔStress |
|---|---|---|---|
| 1.17 | 1 | 1.11 | 0.06 |
| 1.13 | 2 | 1.09 | 0.04 |
| 1.13 | 3 | 1.09 | 0.04 |
| 1.13 | 4 | 1.09 | 0.04 |
| 1.47 | 5 | 1.40 | 0.07 |
| 1.41 | 6 | 1.36 | 0.05 |
| 1.41 | 7 | 1.36 | 0.05 |

The stress appreciably decreased on all operators. The changing configuration had a direct impact on the stress of operators 1, 2, 3, 4 (visual, right manual, left manual, cognitive). The greatest disparity between the two consoles surfaced in tasks 112, 113, 114 which on #1 entailed the manipulation of a page remote from the controlling keyboard. Not only were these tasks time consuming, but the Task Summary Report shows the number of failures of these tasks on #1 to be nearly seven times greater than the same tasks performed on #2 under identical conditions.

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK NO | TASK TYPE | TASK ESS. | COUNTERS REL | COUNTERS FAIL | COUNTERS SKIP | TIME TASK REALIZED MEAN | TIME TASK REALIZED STD | TIME TASK REALIZED MIN. | TIME TASK REALIZED MAX | TIME TASK COMPLETED MEAN | TIME TASK COMPLETED STD | TIME TASK COMPLETED MIN. | TIME TASK COMPLETED MAX | TASK STRESS MEAN | TASK STRESS STD. | TASK STRESS MIN. | TASK STRESS MAX. | TASK COHESIVENESS MEAN | TASK COHESIVENESS STD. | TASK COHESIVENESS MIN. | TASK COHESIVENESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MULT | 1.00 | 117 | 17 | 0 | 242.4 | 7.32 | 238.0 | 282.9 | 256.0 | 13.86 | 238.6 | 303.3 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | MULT | 1.00 | 101 | 1 | 0 | 321.3 | 25.28 | 273.0 | 409.1 | 345.2 | 23.34 | 299.7 | 423.3 | 1.08 | 0.09 | 1.00 | 1.56 | 0.02 | 0.03 | 0.00 | 0.16 |
| 3 | MULT | 1.00 | 141 | 41 | 0 | 751.1 | 132.87 | 573.1 | 1032.6 | 767.6 | 133.26 | 589.8 | 1047.8 | 1.01 | 0.02 | 1.00 | 1.15 | 0.00 | 0.00 | 0.00 | 0.03 |
| 4 | MULT | 1.00 | 101 | 1 | 0 | 1047.0 | 129.37 | 863.4 | 1271.7 | 1057.4 | 129.10 | 873.3 | 1282.5 | 1.00 | 0.02 | 1.00 | 1.08 | 0.00 | 0.00 | 0.00 | 0.02 |
| 5 | MULT | 1.00 | 135 | 35 | 0 | 1265.8 | 143.68 | 1087.7 | 1702.2 | 1282.8 | 145.83 | 1099.8 | 1726.2 | 1.43 | 1.02 | 1.00 | 5.00 | 0.39 | 1.10 | 0.00 | 4.57 |
| 6 | MULT | 1.00 | 100 | 0 | 0 | 1152.1 | 107.66 | 997.5 | 1407.3 | 1164.4 | 106.17 | 1002.6 | 1415.3 | 1.04 | 0.11 | 1.00 | 1.86 | 0.01 | 0.03 | 0.00 | 0.26 |
| 7 | EQMT | 1.00 | 100 | 0 | 0 | 1415.7 | 185.44 | 1261.3 | 2032.2 | 1415.7 | 185.44 | 1261.3 | 2032.2 | | | | | | | | |
| 42 | MULT | 1.00 | 200 | 0 | 0 | 1080.9 | 227.55 | 712.4 | 1726.2 | 1080.9 | 227.55 | 712.4 | 1726.2 | 1.41 | 0.88 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 43 | SING | 1.00 | 200 | 0 | 0 | 1080.9 | 227.55 | 712.4 | 1726.2 | 1110.3 | 229.38 | 743.7 | 1790.8 | 1.52 | 0.97 | 1.00 | 5.00 | 0.32 | 0.96 | 0.00 | 4.57 |
| 44 | SING | 1.00 | 200 | 0 | 0 | 1080.9 | 227.55 | 712.4 | 1726.2 | 1137.4 | 230.24 | 772.6 | 1844.5 | 1.39 | 0.89 | 1.00 | 5.00 | 0.28 | 0.95 | 0.00 | 4.57 |
| 45 | MULT | 1.00 | 200 | 0 | 0 | 1060.9 | 227.55 | 712.4 | 1726.2 | 1137.1 | 230.96 | 772.1 | 1845.2 | 1.50 | 0.96 | 1.00 | 5.00 | 0.32 | 0.96 | 0.00 | 4.57 |
| 46 | SING | 1.00 | 200 | 0 | 0 | 1110.3 | 229.38 | 743.7 | 1790.8 | 1166.8 | 234.49 | 803.5 | 1911.8 | 1.54 | 1.05 | 1.00 | 5.00 | 0.34 | 1.00 | 0.00 | 4.57 |
| 47 | SING | 1.00 | 200 | 0 | 0 | 1080.9 | 227.55 | 712.4 | 1726.2 | 1137.1 | 230.93 | 772.6 | 1846.5 | 1.50 | 0.96 | 1.00 | 5.00 | 0.32 | 0.96 | 0.00 | 4.57 |
| 48 | MULT | 1.00 | 200 | 0 | 0 | 1166.8 | 234.49 | 803.5 | 1911.8 | 1166.8 | 234.49 | 803.5 | 1911.8 | 1.47 | 1.06 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 49 | MULT | 1.00 | 100 | 0 | 0 | 1347.2 | 166.63 | 1201.1 | 1911.8 | 1347.2 | 166.63 | 1201.1 | 1911.8 | 1.56 | 1.39 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 50 | SING | 1.00 | 100 | 0 | 0 | 1347.2 | 166.63 | 1201.1 | 1911.8 | 1347.2 | 166.63 | 1201.1 | 1911.8 | 1.56 | 1.39 | 1.00 | 5.00 | 0.64 | 1.59 | 0.00 | 4.57 |
| 51 | SING | 1.00 | 100 | 0 | 0 | 1347.2 | 166.63 | 1201.1 | 1911.8 | 1415.4 | 185.31 | 1261.0 | 2032.2 | 1.56 | 1.39 | 1.00 | 5.00 | 0.64 | 1.59 | 0.00 | 4.57 |
| 52 | SING | 1.00 | 100 | 0 | 0 | 1347.2 | 166.63 | 1201.1 | 1911.8 | 1347.2 | 166.63 | 1201.1 | 1911.8 | 1.56 | 1.39 | 1.00 | 5.00 | 0.64 | 1.59 | 0.00 | 4.57 |
| 53 | MULT | 1.00 | 100 | 0 | 0 | 1347.2 | 166.63 | 1201.1 | 1911.8 | 1415.3 | 185.75 | 1261.3 | 2031.5 | 1.56 | 1.39 | 1.00 | 5.00 | 0.64 | 1.59 | 0.00 | 4.57 |
| 54 | SING | 1.00 | 100 | 0 | 0 | 1347.2 | 166.63 | 1201.1 | 1911.8 | 1347.2 | 166.63 | 1201.1 | 1911.8 | 1.56 | 1.39 | 1.00 | 5.00 | 0.64 | 1.59 | 0.00 | 4.57 |
| 55 | SING | 1.00 | 100 | 0 | 0 | 1347.2 | 166.63 | 1201.1 | 1911.8 | 1415.4 | 185.36 | 1261.3 | 2032.1 | 1.56 | 1.39 | 1.00 | 5.00 | 0.64 | 1.59 | 0.00 | 4.57 |
| 56 | MULT | 1.00 | 100 | 0 | 0 | 1415.7 | 185.44 | 1261.3 | 2032.2 | 1415.7 | 185.44 | 1261.3 | 2032.2 | 1.56 | 1.39 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 57 | MULT | 1.00 | 300 | 0 | 0 | 998.1 | 206.09 | 590.1 | 1415.3 | 998.1 | 206.09 | 590.1 | 1415.3 | 1.28 | 0.38 | 1.00 | 3.42 | 0.00 | 0.00 | 0.00 | 0.00 |
| 58 | SING | 1.00 | 300 | 0 | 0 | 998.1 | 206.09 | 590.1 | 1415.3 | 1024.4 | 203.30 | 620.4 | 1480.8 | 1.39 | 0.57 | 1.00 | 4.42 | 0.12 | 0.21 | 0.00 | 1.77 |
| 59 | SING | 1.00 | 300 | 0 | 0 | 1024.4 | 203.30 | 620.4 | 1480.8 | 1051.3 | 201.33 | 651.5 | 1535.7 | 1.41 | 0.64 | 1.00 | 5.00 | 0.13 | 0.26 | 0.00 | 2.60 |
| 60 | SING | 1.00 | 300 | 0 | 0 | 1051.3 | 201.33 | 651.5 | 1535.7 | 1051.3 | 201.33 | 651.5 | 1535.7 | 1.44 | 0.77 | 1.00 | 5.00 | 0.14 | 0.32 | 0.00 | 2.68 |
| 61 | SING | 1.00 | 300 | 0 | 0 | 998.1 | 206.09 | 590.1 | 1415.3 | 1075.0 | 195.82 | 680.2 | 1589.7 | 1.26 | 0.41 | 1.00 | 3.44 | 0.08 | 0.15 | 0.00 | 1.39 |
| 62 | SING | 1.00 | 300 | 0 | 0 | 1051.3 | 201.33 | 651.5 | 1535.7 | 1078.4 | 200.00 | 682.6 | 1597.9 | 1.44 | 0.77 | 1.00 | 5.00 | 0.14 | 0.32 | 0.00 | 2.68 |
| 63 | SING | 1.00 | 300 | 0 | 0 | 1078.4 | 200.00 | 682.6 | 1597.9 | 1096.[illegible] | 190.61 | 712.4 | 1597.9 | 1.45 | 0.81 | 1.00 | 5.00 | 0.15 | 0.36 | 0.00 | 2.68 |
| 64 | MULT | 1.00 | 300 | 0 | 0 | 998.1 | 206.09 | 590.1 | 1415.3 | 1074.7 | 197.80 | 680.7 | 1595.5 | 1.36 | 0.54 | 1.00 | 4.02 | 0.12 | 0.21 | 0.00 | 1.77 |
| 65 | SING | 1.00 | 300 | 0 | 0 | 998.1 | 206.09 | 590.1 | 1415.3 | 1074.8 | 197.84 | 680.0 | 1595.8 | 1.36 | 0.54 | 1.00 | 4.02 | 0.12 | 0.21 | 0.00 | 1.77 |
| 66 | MULT | 1.00 | 300 | 0 | 0 | 1097.0 | 191.02 | 712.4 | 1597.9 | 1097.0 | 191.02 | 712.4 | 1597.9 | 1.33 | 0.73 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 77 | MULT | 1.00 | 200 | 0 | 0 | 172.5 | 173.76 | 0.0 | 423.3 | 172.5 | 173.76 | 0.0 | 423.3 | 1.75 | 0.79 | 1.00 | 4.11 | 0.00 | 0.00 | 0.00 | 0.00 |
| 78 | MULT | 1.00 | 212 | 12 | 0 | 169.5 | 173.93 | 0.0 | 423.3 | 169.5 | 173.93 | 0.0 | 423.3 | 1.45 | 0.47 | 1.00 | 2.28 | 0.14 | 0.15 | 0.00 | 0.81 |
| 79 | MULT | 1.00 | 200 | 0 | 0 | 172.5 | 173.76 | 0.0 | 423.3 | 180.7 | 181.95 | 0.0 | 440.9 | 1.46 | 0.47 | 1.00 | 2.28 | 0.14 | 0.15 | 0.00 | 0.81 |
| 80 | MULT | 1.00 | 210 | 10 | 0 | 174.1 | 182.07 | 0.0 | 440.9 | 174.1 | 182.07 | 0.0 | 440.9 | 1.45 | 0.47 | 1.00 | 2.51 | 0.14 | 0.16 | 0.00 | 0.99 |
| 81 | MULT | 1.00 | 200 | 0 | 0 | 180.7 | 181.95 | 0.0 | 440.9 | 180.7 | 181.95 | 0.0 | 440.9 | 1.46 | 0.47 | 1.00 | 2.51 | 0.15 | 0.16 | 0.00 | 0.99 |
| 82 | MULT | 1.00 | 200 | 0 | 0 | 180.7 | 181.95 | 0.0 | 440.9 | 435.2 | 217.29 | 238.0 | 920.1 | 1.87 | 0.93 | 1.00 | 5.00 | 0.17 | 0.19 | 0.00 | 1.20 |
| 83 | MULT | 1.00 | 200 | 0 | 0 | 180.7 | 181.95 | 0.0 | 440.9 | 180.7 | 181.95 | 0.0 | 440.9 | 1.49 | 0.50 | 1.00 | 2.51 | 0.17 | 0.19 | 0.00 | 1.20 |
| 84 | MULT | 1.00 | 204 | 4 | 0 | 178.9 | 181.84 | 0.0 | 440.9 | 178.9 | 181.84 | 0.0 | 440.9 | 1.49 | 0.50 | 1.00 | 2.51 | 0.17 | 0.19 | 0.00 | 1.20 |
| 85 | MULT | 1.00 | 200 | 0 | 0 | 180.7 | 181.95 | 0.0 | 440.9 | 180.7 | 181.95 | 0.0 | 440.9 | 1.49 | 0.50 | 1.00 | 2.51 | 0.17 | 0.19 | 0.00 | 1.20 |
| 86 | MULT | 1.00 | 200 | 0 | 0 | 180.7 | 181.95 | 0.0 | 440.9 | 183.9 | 185.08 | 0.0 | 450.7 | 1.49 | 0.50 | 1.00 | 2.51 | 0.17 | 0.19 | 0.00 | 1.20 |
| 88 | MULT | 1.00 | 200 | 0 | 0 | 435.2 | 217.29 | 238.0 | 920.1 | 435.2 | 217.29 | 238.0 | 920.1 | 1.97 | 1.08 | 1.00 | 4.26 | 0.00 | 0.00 | 0.00 | 0.00 |
| 89 | MULT | 1.00 | 100 | 0 | 0 | 986.4 | 130.36 | 803.5 | 1219.6 | 986.4 | 130.36 | 803.5 | 1219.6 | 1.01 | 0.02 | 1.00 | 1.09 | 0.00 | 0.00 | 0.00 | 0.00 |
| 90 | MULT | 1.00 | 100 | 0 | 0 | 986.4 | 130.36 | 803.5 | 1219.6 | 986.4 | 130.36 | 803.5 | 1219.6 | 1.01 | 0.02 | 1.00 | 1.09 | 0.00 | 0.00 | 0.00 | 0.02 |
| 91 | MULT | 1.00 | 100 | 0 | 0 | 986.4 | 130.36 | 803.5 | 1219.6 | 1045.9 | 129.60 | 863.4 | 1271.7 | 1.01 | 0.02 | 1.00 | 1.09 | 0.00 | 0.00 | 0.00 | 0.02 |
| 92 | MULT | 1.00 | 100 | 0 | 0 | 1045.9 | 129.60 | 863.4 | 1271.7 | 1045.9 | 129.60 | 863.4 | 1271.7 | 1.00 | 0.02 | 1.00 | 1.08 | 0.00 | 0.00 | 0.00 | 0.02 |
| 93 | MULT | 1.00 | 100 | 0 | 0 | 1045.9 | 129.60 | 863.4 | 1271.7 | 1045.9 | 129.60 | 363.4 | 1271.7 | 1.00 | 0.02 | 1.00 | 1.08 | 0.00 | 0.00 | 0.00 | 0.02 |
| 94 | MULT | 1.00 | 100 | 0 | 0 | 1045.9 | 129.60 | 863.4 | 1271.7 | 1045.9 | 129.60 | 863.4 | 1271.7 | 1.00 | 0.02 | 1.00 | 1.08 | 0.00 | 0.00 | 0.00 | 0.00 |
| 95 | MULT | 1.00 | 100 | 0 | 0 | 630.3 | 134.05 | 453.0 | 920.1 | 630.3 | 134.05 | 453.0 | 920.1 | 1.00 | 0.01 | 1.00 | 1.05 | 0.00 | 0.00 | 0.00 | 0.00 |
| 96 | MULT | 1.00 | 100 | 0 | 0 | 630.3 | 134.05 | 453.0 | 920.1 | 690.2 | 133.96 | 512.9 | 975.4 | 1.00 | 0.01 | 1.00 | 1.05 | 0.00 | 0.00 | 0.00 | 0.01 |
| 97 | MULT | 1.00 | 100 | 0 | 0 | 690.2 | 133.96 | 512.9 | 975.4 | 690.2 | 133.[illegible] | [illegible] | 975.[illegible] | [illegible] | [illegible] | [illegible] | 1.05 | 0.00 | 0.00 | 0.00 | 0.01 |
| 98 | SING | 1.00 | 100 | 0 | 0 | 690.2 | 133.96 | 512.9 | 975.4 | 750.2 | 133.[illegible] | [illegible] | 1032.6 | 1.00 | 0.00 | 1.00 | 1.03 | 0.00 | 0.00 | 0.00 | 0.01 |
| 99 | MULT | 1.00 | 100 | 0 | 0 | 690.2 | 133.96 | 512.9 | 975.4 | 750.2 | 133.[illegible] | [illegible] | 1032.5 | 1.00 | 0.00 | 1.00 | 1.03 | 0.00 | 0.00 | 0.00 | 0.01 |

Figure 4-19 #1 Leg 4 (1 of 6)

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | MULT | 1.00 | 100. | 0. | 0 | 690.2 | 133.96 | 512.9 | 975.4 | 690.2 | 133.96 | 512.9 | 975.4 | 1.00 | 0.00 | 1.00 | 1.05 | 0.00 | 0.00 | 0.00 | 0.01 |
| 101 | MULT | 1.00 | 100. | 0 | 0 | 690.2 | 133.96 | 512.9 | 975.4 | 690.2 | 133.96 | 512.9 | 975.4 | 1.00 | 0.00 | 1.00 | 1.05 | 0.00 | 0.00 | 0.00 | 0.01 |
| 102 | MULT | 1.00 | 100 | 0 | 0. | 750.3 | 133.89 | 573.1 | 1032.6 | 750.3 | 133.89 | 573.1 | 1032.6 | 1.01 | 0.03 | 1.00 | 1.15 | 0.00 | 0.00 | 0.00 | 0.00 |
| 111 | MULT | 1.00 | 100. | 0. | 0. | 255.9 | 14.18 | 238.6 | 303.3 | 255.9 | 14.18 | 238.6 | 303.3 | 1.00 | 0.00 | 1.00 | 1.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| 112 | MULT | 1.00 | 127. | 27. | 0. | 259.8 | 15.47 | 238.6 | 303.3 | 276.2 | 16.02 | 244.8 | 323.6 | 1.00 | 0.00 | 1.00 | 1.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| 113 | MULT | 1.00 | 135. | 35. | 0. | 232.9 | 22.03 | 244.8 | 378.4 | 298.9 | 22.75 | 259.3 | 391.8 | 1.00 | 0.00 | 1.00 | 1.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| 114 | MULT | 1.00 | 141. | 41. | 0. | 304.3 | 23.92 | 259.3 | 391.8 | 320.3 | 24.38 | 271.8 | 409.1 | 1.00 | 0.00 | 1.00 | 1.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| 115 | MULT | 1.00 | 100. | 0 | 0. | 320.9 | 25.18 | 273.0 | 409.1 | 320.9 | 25.18 | 273.0 | 409.1 | 1.00 | 0.00 | 1.00 | 1.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| 116 | MULT | 1.00 | 100. | 0 | 0 | 320.9 | 25.18 | 273.0 | 409.1 | 320.9 | 25.18 | 273.0 | 409.1 | 1.12 | 0.14 | 1.00 | 1.83 | 0.00 | 0.00 | 0.00 | 0.00 |

Figure 4-19 #1 Leg 4 (2 of 6)

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD. | BUSY TIME MIN | BUSY TIME MAX | IDLE TIME MEAN | IDLE TIME STD | IDLE TIME MIN | IDLE TIME MAX | TOTAL TIME USED MEAN | TOTAL TIME USED STD. | TOTAL TIME USED MIN. | TOTAL TIME USED MAX. | STRESS MEAN | STRESS STD. | STRESS MIN. | STRESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1600.00 | 781.9 | 90.5 | 678.4 | 1144.3 | 633.8 | 124.7 | 486.5 | 897.3 | 1415.7 | 185.4 | 1261.3 | 2032.2 | 1.17 | 0.31 | 1.01 | 2.28 |
| 2 | 1600.00 | 726.6 | 87.2 | 638.4 | 1089.9 | 689.0 | 122.8 | 543.7 | 947.4 | 1415.7 | 185.4 | 1261.3 | 2032.2 | 1.13 | 0.27 | 1.00 | 2.11 |
| 3 | 1600.00 | 726.6 | 87.2 | 638.4 | 1089.9 | 689.0 | 122.8 | 543.7 | 947.4 | 1415.7 | 185.4 | 1261.3 | 2032.2 | 1.13 | 0.27 | 1.00 | 2.11 |
| 4 | 1600.00 | 726.7 | 87.4 | 638.4 | 1092.2 | 689.0 | 122.6 | 543.6 | 946.1 | 1415.7 | 185.4 | 1261.3 | 2032.2 | 1.13 | 0.27 | 1.00 | 2.11 |
| 5 | 1600.00 | 980.6 | 29.4 | 859.6 | 1374.2 | 435.0 | 64.7 | 364.3 | 716.9 | 1415.7 | 185.4 | 1261.3 | 2032.2 | 1.47 | 0.39 | 1.14 | 2.88 |
| 6 | 1600.00 | 568.9 | 111.2 | 434.3 | 782.0 | 846.8 | 108.1 | 742.5 | 1263.0 | 1415.7 | 185.4 | 1261.3 | 2032.2 | 1.41 | 0.28 | 1.14 | 2.58 |
| 7 | 1600.00 | 568.9 | 111.2 | 434.3 | 782.0 | 846.8 | 108.1 | 742.5 | 1263.0 | 1415.7 | 185.4 | 1261.3 | 2032.2 | 1.41 | 0.28 | 1.14 | 2.58 |

86 SUCCESSFUL MISSIONS

14 UNSUCCESSFUL MISSIONS

Figure 4-19 #1 Leg 4 (3 of 6)

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK NO | TASK TYPE | TASK ESS. | ---COUNTERS--- REL. | FAIL | SKIP | -----TIME TASK REALIZED---- MEAN | STD. | MIN. | MAX. | ----TIME TASK COMPLETED---- MEAN | STD. | MIN. | MAX. | ----TASK STRESS---- MEAN | STD. | MIN. | MAX. | -TASK COHESIVENESS- MEAN | STD. | MIN. | MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MULT | 1.00 | 150. | 50 | 0. | 247.6 | 14.08 | 238.2 | 310.0 | 265.9 | 19.68 | 239.1 | 334.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | MULT | 1.00 | 100. | 0 | 0. | 315.9 | 25.04 | 253.9 | 385.0 | 339.4 | 23.07 | 277.2 | 400.6 | 1.07 | 0.08 | 1.00 | 1.37 | 0.02 | 0.02 | 0.00 | 0.10 |
| 3 | MULT | 1.00 | 105 | 5 | 0. | 721.1 | 124.44 | 545.3 | 1017.2 | 739.5 | 124.48 | 555.9 | 1039.5 | 1.00 | 0.02 | 1.00 | 1.10 | 0.00 | 0.00 | 0.00 | 0.02 |
| 4 | MULT | 1.00 | 108. | 8. | 0. | 1021.8 | 119.38 | 841.9 | 1275.9 | 1033.1 | 119.67 | 841.9 | 1290.9 | 1.00 | 0.01 | 1.00 | 1.08 | 0.00 | 0.00 | 0.00 | 0.01 |
| 5 | MULT | 1.00 | 106. | 6. | 0. | 1237.3 | 145.91 | 1075.1 | 1735.6 | 1252.7 | 147.19 | 1093.5 | 1735.6 | 1.34 | 0.99 | 1.00 | 5.00 | 0.34 | 1.09 | 0.00 | 4.57 |
| 6 | MULT | 1.00 | 100. | 0. | 0. | 1131.4 | 103.72 | 967.6 | 1453.9 | 1144.9 | 101.52 | 985.1 | 1464.2 | 1.04 | 0.19 | 1.00 | 2.61 | 0.01 | 0.06 | 0.00 | 0.58 |
| 7 | EGMT | 1.00 | 100. | 0. | 0. | 1373.9 | 157.78 | 1249.6 | 2030.7 | 1373.9 | 157.78 | 1249.6 | 2030.7 | | | | | | | | |
| 42 | MULT | 1.00 | 200. | 0 | 0. | 1051.4 | 220.96 | 690.6 | 1734.0 | 1051.4 | 220.96 | 690.6 | 1734.0 | 1.30 | 0.76 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 43 | SING | 1.00 | 200. | 0 | 0. | 1051.4 | 220.96 | 690.6 | 1734.0 | 1079.2 | 220.14 | 721.5 | 1789.1 | 1.37 | 0.80 | 1.00 | 5.00 | 0.23 | 0.84 | 0.00 | 4.57 |
| 44 | SING | 1.00 | 200. | 0. | 0. | 1051.4 | 220.96 | 690.6 | 1734.0 | 1107.1 | 221.19 | 750.7 | 1854.6 | 1.27 | 0.76 | 1.00 | 5.00 | 0.20 | 0.84 | 0.00 | 4.57 |
| 45 | MULT | 1.00 | 200. | 0. | 0. | 1051.4 | 220.96 | 690.6 | 1734.0 | 1105.5 | 219.99 | 750.8 | 1854.2 | 1.35 | 0.79 | 1.00 | 5.00 | 0.23 | 0.84 | 0.00 | 4.57 |
| 46 | SING | 1.00 | 200 | 0 | 0 | 1079.2 | 220.14 | 721.5 | 1789.1 | 1132.9 | 219.83 | 781.5 | 1909.3 | 1.37 | 0.81 | 1.00 | 5.00 | 0.23 | 0.86 | 0.00 | 4.57 |
| 47 | SING | 1.00 | 200. | 0. | 0. | 1051.4 | 220.96 | 690.6 | 1734.0 | 1105.5 | 219.99 | 750.9 | 1853.8 | 1.35 | 0.79 | 1.00 | 5.00 | 0.23 | 0.84 | 0.00 | 4.57 |
| 48 | MULT | 1.00 | 200 | 0. | 0. | 1132.9 | 219.83 | 781.5 | 1909.3 | 1132.9 | 219.83 | 781.5 | 1909.3 | 1.29 | 0.79 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 49 | MULT | 1.00 | 100. | 0 | 0. | 1308.8 | 142.47 | 1189.4 | 1909.3 | 1308.8 | 142.47 | 1189.4 | 1909.3 | 1.32 | 1.09 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 50 | SING | 1.00 | 100. | 0. | 0. | 1308.8 | 142.47 | 1189.4 | 1909.3 | 1308.8 | 142.47 | 1189.4 | 1909.3 | 1.32 | 1.09 | 1.00 | 5.00 | 0.37 | 1.25 | 0.00 | 4.57 |
| 51 | SING | 1.00 | 100. | 0. | 0. | 1308.8 | 142.47 | 1189.4 | 1909.3 | 1373.6 | 157.72 | 1249.6 | 2030.1 | 1.32 | 1.09 | 1.00 | 5.00 | 0.37 | 1.25 | 0.00 | 4.57 |
| 52 | SING | 1.00 | 100. | 0. | 0. | 1308.8 | 142.47 | 1189.4 | 1907.3 | 1308.8 | 142.47 | 1189.4 | 1909.3 | 1.32 | 1.09 | 1.00 | 5.00 | 0.37 | 1.25 | 0.00 | 4.57 |
| 53 | MULT | 1.00 | 100. | 0. | 0. | 1308.8 | 142.47 | 1189.4 | 1909.3 | 1373.6 | 157.71 | 1249.0 | 2030.7 | 1.32 | 1.09 | 1.00 | 5.00 | 0.37 | 1.25 | 0.00 | 4.57 |
| 54 | SING | 1.00 | 100. | 0. | 0 | 1308.8 | 142.47 | 1189.4 | 1909.3 | 1308.8 | 142.47 | 1189.4 | 1909.3 | 1.32 | 1.09 | 1.00 | 5.00 | 0.37 | 1.25 | 0.00 | 4.57 |
| 55 | SING | 1.00 | 100. | 0. | 0. | 1308.8 | 142.47 | 1189.4 | 1909.3 | 1373.6 | 157.70 | 1249.6 | 2030.1 | 1.32 | 1.09 | 1.00 | 5.00 | 0.37 | 1.25 | 0.00 | 4.57 |
| 56 | MULT | 1.00 | 100. | 0 | 0. | 1373.9 | 157.78 | 1249.6 | 2030.7 | 1373.9 | 157.78 | 1249.6 | 2030.7 | 1.32 | 1.09 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 57 | MULT | 1.00 | 300. | 0. | 0. | 972.7 | 203.95 | 566.6 | 1464.2 | 972.7 | 203.95 | 566.6 | 1464.2 | 1.22 | 0.38 | 1.00 | 4.59 | 0.00 | 0.00 | 0.00 | 0.00 |
| 58 | SING | 1.00 | 300. | 0 | 0. | 972.7 | 203.95 | 566.6 | 1464.2 | 999.2 | 200.99 | 598.5 | 1525.8 | 1.31 | 0.53 | 1.00 | 5.00 | 0.10 | 0.26 | 0.00 | 3.37 |
| 59 | SING | 1.00 | 300. | 0. | 0. | 999.2 | 200.99 | 598.5 | 1525.8 | 1026.0 | 198.60 | 629.5 | 1589.8 | 1.31 | 0.58 | 1.00 | 5.00 | 0.10 | 0.30 | 0.00 | 3.69 |
| 60 | SING | 1.00 | 300. | 0. | 0. | 1026.0 | 198.60 | 629.5 | 1589.8 | 1026.0 | 198.60 | 629.5 | 1589.8 | 1.33 | 0.67 | 1.00 | 5.00 | 0.11 | 0.34 | 0.00 | 3.69 |
| 61 | SING | 1.00 | 300. | 0. | 0. | 972.7 | 203.95 | 566.6 | 1464.2 | 1051.9 | 195.53 | 656.4 | 1645.0 | 1.20 | 0.39 | 1.00 | 4.31 | 0.07 | 0.20 | 0.00 | 2.71 |
| 62 | SING | 1.00 | 300. | 0. | 0. | 1026.0 | 198.60 | 629.5 | 1589.8 | 1053.0 | 196.65 | 660.9 | 1650.2 | 1.33 | 0.67 | 1.00 | 5.00 | 0.11 | 0.34 | 0.00 | 3.69 |
| 63 | SING | 1.00 | 300. | 0. | 0. | 1053.0 | 196.65 | 660.9 | 1650.2 | 1071.4 | 187.54 | 690.6 | 1650.2 | 1.33 | 0.69 | 1.00 | 5.00 | 0.12 | 0.37 | 0.00 | 3.69 |
| 64 | MULT | 1.00 | 300. | 0 | 0. | 972.7 | 203.95 | 566.6 | 1464.2 | 1050.8 | 195.79 | 657.0 | 1644.0 | 1.28 | 0.50 | 1.00 | 5.00 | 0.10 | 0.26 | 0.00 | 3.37 |
| 65 | SING | 1.00 | 300 | 0. | 0. | 972.7 | 203.95 | 566.6 | 1464.2 | 1050.7 | 195.81 | 656.6 | 1644.0 | 1.28 | 0.50 | 1.00 | 5.00 | 0.10 | 0.26 | 0.00 | 3.36 |
| 66 | MULT | 1.00 | 300. | 0. | 0. | 1072.7 | 188.41 | 690.6 | 1650.2 | 1072.7 | 188.41 | 690.6 | 1650.2 | 1.25 | 0.65 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 77 | MULT | 1.00 | 200. | 0. | 0. | 169.7 | 170.90 | 0.0 | 400.6 | 169.7 | 170.90 | 0.0 | 400.6 | 1.71 | 0.75 | 1.00 | 3.45 | 0.00 | 0.00 | 0.00 | 0.00 |
| 78 | MULT | 1.00 | 208 | 8 | 0. | 164.8 | 170.75 | 0.0 | 400.6 | 164.8 | 170.75 | 0.0 | 400.6 | 1.44 | 0.46 | 1.00 | 2.07 | 0.13 | 0.14 | 0.00 | 0.51 |
| 79 | MULT | 1.00 | 200 | 0. | 0. | 169.7 | 170.90 | 0.0 | 400.6 | 177.9 | 179.06 | 0.0 | 417.5 | 1.45 | 0.46 | 1.00 | 2.07 | 0.14 | 0.14 | 0.00 | 0.51 |
| 80 | MULT | 1.00 | 205. | 5. | 0. | 176.9 | 178.94 | 0.0 | 417.5 | 176.9 | 178.94 | 0.0 | 417.5 | 1.45 | 0.46 | 1.00 | 2.22 | 0.14 | 0.15 | 0.00 | 0.61 |
| 81 | MULT | 1.00 | 200. | 0. | 0. | 177.9 | 179.06 | 0.0 | 417.5 | 177.9 | 179.06 | 0.0 | 417.5 | 1.45 | 0.46 | 1.00 | 2.22 | 0.14 | 0.15 | 0.00 | 0.61 |
| 82 | MULT | 1.00 | 200. | 0. | 0. | 177.9 | 179.06 | 0.0 | 417.5 | 424.0 | 204.00 | 238.2 | 896.9 | 1.83 | 0.87 | 1.00 | 4.06 | 0.16 | 0.17 | 0.00 | 0.72 |
| 83 | MULT | 1.00 | 200. | 0. | 0. | 177.9 | 179.06 | 0.0 | 417.5 | 177.9 | 179.06 | 0.0 | 417.5 | 1.48 | 0.49 | 1.00 | 2.22 | 0.16 | 0.17 | 0.00 | 0.72 |
| 84 | MULT | 1.00 | 203. | 3. | 0. | 180.4 | 178.92 | 0.0 | 417.5 | 180.4 | 173.92 | 0.0 | 417.5 | 1.49 | 0.49 | 1.00 | 2.22 | 0.16 | 0.17 | 0.00 | 0.72 |
| 85 | MULT | 1.00 | 200. | 0. | 0. | 177.9 | 179.06 | 0.0 | 417.5 | 177.9 | 179.06 | 0.0 | 417.5 | 1.48 | 0.49 | 1.00 | 2.22 | 0.16 | 0.17 | 0.00 | 0.72 |
| 86 | MULT | 1.00 | 200. | 0. | 0. | 177.9 | 179.06 | 0.0 | 417.5 | 183.0 | 184.32 | 0.0 | 427.8 | 1.48 | 0.49 | 1.00 | 2.22 | 0.16 | 0.17 | 0.00 | 0.72 |
| 88 | MULT | 1.00 | 200. | 0. | 0. | 424.0 | 204.00 | 238.2 | 896.9 | 424.0 | 204.00 | 238.2 | 896.9 | 1.94 | 1.05 | 1.00 | 4.21 | 0.00 | 0.00 | 0.00 | 0.00 |
| 89 | MULT | 1.00 | 100 | 0 | 0. | 957.0 | 119.75 | 781.5 | 1223.2 | 957.0 | 119.75 | 781.5 | 1223.2 | 1.00 | 0.01 | 1.00 | 1.09 | 0.00 | 0.00 | 0.00 | 0.00 |
| 90 | MULT | 1.00 | 100 | 0. | 0. | 957.0 | 119.75 | 781.5 | 1223.2 | 957.0 | 119.75 | 781.5 | 1223.2 | 1.00 | 0.01 | 1.00 | 1.09 | 0.00 | 0.00 | 0.00 | 0.02 |
| 91 | MULT | 1.00 | 100 | 0. | 0. | 957.0 | 119.75 | 781.5 | 1223.2 | 1016.7 | 119.10 | 841.9 | 1275.9 | 1.00 | 0.01 | 1.00 | 1.09 | 0.00 | 0.00 | 0.00 | 0.02 |
| 92 | MULT | 1.00 | 100. | 0. | 0. | 1016.7 | 119.10 | 841.9 | 1275.9 | 1016.7 | 119.10 | 841.9 | 1275.9 | 1.00 | 0.01 | 1.00 | 1.08 | 0.00 | 0.00 | 0.00 | 0.01 |
| 93 | MULT | 1.00 | 100. | 0. | 0. | 1016.7 | 119.10 | 841.9 | 1275.9 | 1016.7 | 119.10 | 841.9 | 1275.9 | 1.00 | 0.01 | 1.00 | 1.08 | 0.00 | 0.00 | 0.00 | 0.01 |
| 94 | MULT | 1.00 | 100 | 0 | 0. | 1016.7 | 119.10 | 841.9 | 1275.9 | 1016.7 | 119.10 | 841.9 | 1275.9 | 1.00 | 0.01 | 1.00 | 1.08 | 0.00 | 0.00 | 0.00 | 0.00 |
| 95 | MULT | 1.00 | 100. | 0. | 0. | 608.0 | 123.57 | 424.9 | 896.9 | 608.0 | 123.57 | 424.9 | 896.9 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 96 | MULT | 1.00 | 100 | 0 | 0. | 608.0 | 123.57 | 424.9 | 896.9 | 668.0 | 123.59 | 485.0 | 956.8 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 97 | MULT | 1.00 | 100 | 0. | 0. | 668.0 | 123.59 | 485.0 | 956.8 | 668.0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 98 | SING | 1.00 | 100. | 0 | 0 | 668.0 | 123.59 | 485.0 | 956.8 | 728.0 | [illegible] | [illegible] | 1017.2 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 99 | MULT | 1.00 | 100 | 0. | 0. | 668.0 | 123.59 | 485.0 | 956.8 | 728.0 | [illegible] | [illegible] | 1016.9 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Figure 4-19 #2 Leg 4 (4 of 6)

| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | MULT | 1.00 | 100. | 0. | 0. | 668.0 | 123.59 | 485.0 | 956.8 | 668.0 | 123.59 | 485.0 | 956.8 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 101 | MULT | 1.00 | 100. | 0. | 0. | 668.0 | 123.59 | 485.0 | 956.8 | 668.0 | 123.59 | 485.0 | 956.8 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 102 | MULT | 1.00 | 100. | 0. | 0. | 728.1 | 123.59 | 545.3 | 1017.2 | 728.1 | 123.59 | 545.3 | 1017.2 | 1.00 | 0.02 | 1.00 | 1.10 | 0.00 | 0.00 | 0.00 | 0.00 |
| 111 | MULT | 1.00 | 100. | 0. | 0. | 267.5 | 21.26 | 239.1 | 334.6 | 267.5 | 21.26 | 239.1 | 334.6 | 1.01 | 0.03 | 1.00 | 1.17 | 0.00 | 0.00 | 0.00 | 0.00 |
| 112 | MULT | 1.00 | 104. | 4. | 0. | 268.6 | 21.95 | 239.1 | 334.6 | 284.1 | 22.71 | 240.9 | 350.6 | 1.00 | 0.02 | 1.00 | 1.11 | 0.00 | 0.00 | 0.00 | 0.03 |
| 113 | MULT | 1.00 | 103. | 3. | 0. | 283.3 | 22.47 | 240.9 | 350.6 | 298.4 | 24.95 | 240.9 | 368.5 | 1.00 | 0.02 | 1.00 | 1.11 | 0.00 | 0.00 | 0.00 | 0.03 |
| 114 | MULT | 1.00 | 102. | 2. | 0. | 299.5 | 24.73 | 240.9 | 368.5 | 315.8 | 24.88 | 253.9 | 385.0 | 1.00 | 0.02 | 1.00 | 1.11 | 0.00 | 0.00 | 0.00 | 0.03 |
| 115 | MULT | 1.00 | 100. | 0. | 0. | 315.9 | 25.04 | 253.9 | 385.0 | 315.9 | 25.04 | 253.9 | 385.0 | 1.00 | 0.02 | 1.00 | 1.11 | 0.00 | 0.00 | 0.00 | 0.03 |
| 116 | MULT | 1.00 | 100. | 0. | 0. | 315.9 | 25.04 | 253.9 | 385.0 | 315.9 | 25.04 | 253.9 | 385.0 | 1.10 | 0.12 | 1.00 | 1.55 | 0.00 | 0.00 | 0.00 | 0.00 |

Figure 4-19 #2 Leg 4 (5 of 6)

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD. | BUSY TIME MIN. | BUSY TIME MAX. | IDLE TIME MEAN | IDLE TIME STD. | IDLE TIME MIN. | IDLE TIME MAX. | TOTAL TIME USED MEAN | TOTAL TIME USED STD. | TOTAL TIME USED MIN. | TOTAL TIME USED MAX. | STRESS MEAN | STRESS STD. | STRESS MIN. | STRESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1600.00 | 762.9 | 77.9 | 670.3 | 1130.1 | 610.9 | 112.9 | 476.4 | 900.6 | 1373.9 | 157.8 | 1249.6 | 2030.7 | 1.11 | 0.26 | 1.00 | 2.25 |
| 2 | 1600.00 | 711.0 | 72.5 | 628.6 | 1026.9 | 662.9 | 108.0 | 538.7 | 1003.7 | 1373.9 | 157.8 | 1249.6 | 2030.7 | 1.09 | 0.23 | 1.00 | 2.12 |
| 3 | 1600.00 | 711.0 | 72.5 | 628.6 | 1026.9 | 662.9 | 108.0 | 538.7 | 1003.7 | 1373.9 | 157.8 | 1249.6 | 2030.7 | 1.09 | 0.23 | 1.00 | 2.12 |
| 4 | 1600.00 | 710.9 | 72.4 | 629.4 | 1024.8 | 663.0 | 108.0 | 540.2 | 1005.9 | 1373.9 | 157.8 | 1249.6 | 2030.7 | 1.09 | 0.23 | 1.00 | 2.12 |
| 5 | 1600.00 | 966.1 | 116.6 | 865.1 | 1392.0 | 407.8 | 47.0 | 358.8 | 638.7 | 1373.9 | 157.8 | 1249.6 | 2030.7 | 1.40 | 0.34 | 1.11 | 2.64 |
| 6 | 1600.00 | 552.4 | 101.7 | 430.5 | 781.1 | 821.5 | 91.9 | 731.6 | 1250.4 | 1373.9 | 157.8 | 1249.6 | 2030.7 | 1.36 | 0.24 | 1.11 | 2.38 |
| 7 | 1600.00 | 552.4 | 101.7 | 430.5 | 781.1 | 821.5 | 91.9 | 731.6 | 1250.4 | 1373.9 | 157.8 | 1249.6 | 2030.7 | 1.36 | 0.24 | 1.11 | 2.38 |

92 SUCCESSFUL MISSIONS

8 UNSUCCESSFUL MISSIONS

Figure 4-19 #2 Leg 4 (6 of 6)

4.1.2.2 Test and Demonstration Results (Cont'd)

These results can be explained. Both the visual and manual operators had less movements to perform. The cumulative effect of these movements detracted less from the total allowed time causing less stress, fewer mistakes and, therefore, more successful missions. The other operators experienced a reduction in stress as a result of the lowering of the disorganizing influence of operators 1, 2 and 3.

The tasks in which the differences between #1 and #2 become clear in leg 5 of the RTP are:

| #1 Parameter Set | Task | #2 Parameter Set |
|---|---|---|
| J | 1 | K |
| A | 97 | B |
| G | 100 | H |
| A | 101 | B |
| A | 21 | B |
| A | 59 | B |
| G | 125 | H |
| A | 126 | B |
| A | 135 | B |
| A | 126 | B |
| A | 143 | B |
| A | 135 | B |
| F | 5 | E |
| D | 68 | C |
| A | 69 | B |

The following parameters remained constant for #1 and #2 in leg 5 of the RTP:

| | | |
|---|---|---|
| Time allowed for mission | : | 1530.00 seconds |
| Operator speed factor | : | 1.0 |
| Operator accuracy factor | : | 1.0 |
| Operator stress threshold | : | 2.5 |

4.1.2.2 Test and Demonstration Results (Cont'd)

The following tasks were initially declared dormant for #1 and #2, either because they were not needed or because they did not apply to the jet trainer configurations:

Tasks

| | | |
|---|---|---|
| 95 | 127 | 74 |
| 98 | 129 | 76 |
| 99 | 131 | |
| 101 | 132 | |
| 102 | 140 | |
| 21 | 141 | |
| 25 | 147 | |
| 57 | 89 | |
| 60 | 92 | |
| 63 | 93 | |
| 66 | 94 | |
| 123 | 67 | |

SAINT's results for running #1 and #2 are shown in Figure 4-20.

The Mission Summary Reports show 70 successful missions for #1 and 80 successes for #2. The Task Summary Report shows the times of completion for leg 5 of the RTP to be:

Time Task Completed (in seconds)

| | Mean | Min. | Max. | Std. |
|---|---|---|---|---|
| #1 | 1470.9 | 1263.3 | 1778.9 | 121.19 |
| #2 | 1457.8 | 1294.3 | 1799.2 | 107.71 |

By using the parameter sets for #2 instead of #1, the average time necessary to complete leg 5 of the RTP was reduced by 13.1 seconds. In #2, these 13.1 seconds resulted in 10 more successful missions than #1.

A comparison of the average stress felt by the operators in #1 and #2 is shown in Table 4-6.

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK NO. | TASK TYPE | TASK SUC | --COUNTERS-- REL | FAIL | SKIP | ---TIME TASK REALIZED MEAN | STD | MIN | MAX | --- TIME TASK COMPLETED---- MEAN | STD | MIN | MAX | ----TASK STRESS---- MEAN | STD | MIN | MAX | -TASK COHESIVENESS- MEAN | STD | MIN | MAX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MULT | 1 00 | 100 | 2 | 0 | 0 5 | 3 06 | 0 0 | 29 9 | 27 8 | 5 35 | 19 3 | 58 1 | 1 00 | 0 00 | 1 00 | 1 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| 2 | MULT | 1 00 | 100 | [illegible] | 0 | 27 7 | 5 75 | 19 3 | 58 1 | 27 7 | 5 35 | 19 3 | 58 1 | 1 00 | 0 00 | 1 00 | 1 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| 3 | MULT | 1 00 | 100 | 3 | 0 | 546 4 | 11 19 | 519 3 | 574 4 | 562 0 | 13 19 | 529 8 | 596 8 | 1 02 | 0 02 | 1 00 | 1 06 | 0 00 | 0 00 | 0 00 | 0 01 |
| 4 | MULT | 1 00 | 103 | 8 | 0 | 563 4 | 14 44 | 529 8 | 607 0 | 578 1 | 15 12 | 542 6 | 617 0 | 1 03 | 0 02 | 1 00 | 1 10 | 0 00 | 0 00 | 0 00 | 0 02 |
| 5 | MULT | 1 00 | 100 | 0 | 0 | 1247 0 | 62 26 | 1055 7 | 1358 4 | 1256 8 | 62 32 | 1060 9 | 1374 5 | 1 58 | 0 72 | 1 00 | 3 09 | 0 11 | 0 14 | 0 00 | 0 40 |
| 6 | EGMT | 1 00 | 100 | 0 | 0 | 1470 9 | 121 19 | 1263 3 | 1778 9 | 1470 9 | 121 19 | 1263 3 | 1778 9 | | | | | | | | |
| [illegible] | MULT | 1 00 | 100 | 0 | 0 | 815 5 | 8 97 | 788 5 | 834 0 | 815 5 | 8 97 | 788 5 | 834 0 | 1 02 | 0 02 | 1 00 | 1 06 | 0 00 | 0 00 | 0 00 | 0 01 |
| [illegible] | MULT | 1 00 | 100 | 0 | 0 | 105 9 | 8 05 | 89 0 | 137 3 | 105 9 | 8 05 | 89 0 | 137 3 | 1 00 | 0 00 | 1 00 | 1 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | SING | 1 00 | 100 | 0 | 0 | 105 9 | 8 05 | 89 0 | 137 3 | 137 2 | 7 97 | 120 0 | 168 1 | 1 00 | 0 00 | 1 00 | 1 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | SING | 1 00 | 100 | 0 | 0 | 137 2 | 7 97 | 120 0 | 168 1 | 137 2 | 7 97 | 120 0 | 168 1 | 1 00 | 0 00 | 1 00 | 1 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | MULT | 1 00 | 100 | 0 | 0 | 105 9 | 8 05 | 89 0 | 137 3 | 226 1 | 8 15 | 208 8 | 256 7 | 1 00 | 0 00 | 1 00 | 1 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | SING | 1 00 | 100 | 0 | 0 | 105 9 | 8 05 | 89 0 | 137 3 | 226 0 | 8 13 | 209 6 | 257 8 | 1 00 | 0 00 | 1 00 | 1 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | MULT | 1 00 | 100 | 0 | 0 | 226 5 | 8 13 | 209 6 | 257 8 | 226 5 | 8 13 | 209 6 | 257 8 | 1 03 | 0 01 | 1 01 | 1 06 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | MULT | 1 00 | 100 | 0 | 0 | 226 5 | 8 13 | 209 6 | 257 8 | 226 5 | 8 13 | 209 6 | 257 8 | 1 03 | 0 01 | 1 01 | 1 06 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | SING | 1 00 | 100 | 0 | 0 | 226 5 | 8 13 | 209 6 | 257 8 | 256 1 | 7 77 | 240 3 | 285 3 | 1 03 | 0 01 | 1 01 | 1 06 | 0 01 | 0 00 | 0 00 | 0 01 |
| [illegible] | SING | 1 00 | 100 | 0 | 0 | 255 1 | 7 77 | 210 3 | 285 3 | 285 8 | 7 52 | 269 5 | 313 1 | 1 03 | 0 01 | 1 01 | 1 06 | 0 01 | 0 00 | 0 00 | 0 01 |
| [illegible] | SING | 1 00 | 100 | 0 | 0 | 285 8 | 7 52 | 269 5 | 313 1 | 285 8 | 7 52 | 269 5 | 313 1 | 1 03 | 0 01 | 1 01 | 1 06 | 0 01 | 0 00 | 0 00 | 0 01 |
| [illegible] | SING | 1 00 | 100 | 0 | 0 | 226 5 | 8 13 | 209 6 | 257 8 | 371 7 | 6 94 | 358 1 | 399 0 | 1 02 | 0 01 | 1 01 | 1 04 | 0 01 | 0 00 | 0 00 | 0 01 |
| [illegible] | SING | 1 00 | 100 | 0 | 0 | 295 8 | 7 52 | 269 5 | 313 1 | 428 7 | 5 87 | 415 2 | 450 0 | 1 03 | 0 01 | 1 01 | 1 06 | 0 01 | 0 00 | 0 00 | 0 01 |
| [illegible] | SING | 1 00 | 100 | 0 | 0 | 428 7 | 5 87 | 415 2 | 450 0 | 428 7 | 5 87 | 415 2 | 450 0 | 1 03 | 0 01 | 1 01 | 1 06 | 0 01 | 0 00 | 0 00 | 0 01 |
| [illegible] | MULT | 1 00 | 100 | 0 | 0 | 226 5 | 8 13 | 207 6 | 257 8 | 371 7 | 6 97 | 356 6 | 398 0 | 1 02 | 0 01 | 1 01 | 1 04 | 0 01 | 0 00 | 0 00 | 0 01 |
| [illegible] | SING | 1 00 | 100 | 0 | 0 | 226 5 | 8 13 | 209 6 | 257 8 | 371 6 | 6 82 | 356 9 | 397 8 | 1 02 | 0 01 | 1 01 | 1 04 | 0 01 | 0 00 | 0 00 | 0 01 |
| [illegible] | MULT | 1 00 | 100 | 0 | 0 | 423 7 | 5 87 | 415 2 | 450 0 | 428 7 | 5 87 | 415 2 | 450 0 | 1 03 | 0 01 | 1 01 | 1 06 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | MULT | 1 00 | 100 | 0 | 0 | 1255 0 | 62 32 | 1060 9 | 1374 5 | 1255 8 | 62 32 | 1060 9 | 1374 5 | 1 05 | 0 08 | 1 00 | 1 37 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | MULT | 1 00 | 100 | 0 | 0 | 1256 8 | 62 32 | 1060 9 | 1374 5 | 1267 1 | 61 43 | 1069 1 | 1376 7 | 1 07 | 0 13 | 1 00 | 1 57 | 0 02 | 0 03 | 0 00 | 0 15 |
| [illegible] | SING | 1 00 | 100 | 0 | 0 | 1267 1 | 61 43 | 1069 1 | 1376 7 | 1296 1 | 57 99 | 1098 5 | 1394 7 | 1 06 | 0 12 | 1 00 | 1 51 | 0 02 | 0 03 | 0 00 | 0 14 |
| [illegible] | SING | 1 00 | 100 | 0 | 0 | 1295 1 | 57 99 | 1098 5 | 1394 7 | 1324 9 | 55 02 | 1128 4 | 1412 1 | 1 05 | 0 10 | 1 00 | 1 46 | 0 01 | 0 03 | 0 00 | 0 12 |
| [illegible] | SING | 1 00 | 100 | 0 | 0 | 1324 9 | 55 02 | 1128 4 | 1412 1 | 1347 6 | 53 13 | 1151 9 | 1426 7 | 1 04 | 0 08 | 1 00 | 1 38 | 0 01 | 0 02 | 0 00 | 0 10 |
| [illegible] | SING | 1 00 | 100 | 0 | 0 | 1347 6 | 53 13 | 1151 9 | 1426 7 | 1376 3 | 51 07 | 1182 9 | 1448 9 | 1 04 | 0 07 | 1 00 | 1 31 | 0 01 | 0 02 | 0 00 | 0 09 |
| [illegible] | MULT | 1 00 | 100 | 0 | 0 | 1256 8 | 62 32 | 1060 9 | 1374 5 | 1371 9 | 54 96 | 1180 6 | 1458 9 | 1 03 | 0 06 | 1 00 | 1 24 | 0 01 | 0 02 | 0 00 | 0 07 |
| [illegible] | MULT | 1 00 | 100 | 0 | 0 | 1376 3 | 51 07 | 1182 9 | 1448 9 | 1376 3 | 51 07 | 1182 9 | 1448 9 | 1 02 | 0 05 | 1 00 | 1 22 | 0 01 | 0 01 | 0 00 | 0 06 |
| [illegible] | SING | 1 00 | 100 | 0 | 0 | 1256 8 | 62 32 | 1060 9 | 1374 5 | 1368 2 | 49 82 | 1180 5 | 1440 7 | 1 06 | 0 12 | 1 00 | 1 56 | 0 02 | 0 03 | 0 00 | 0 15 |
| [illegible] | MULT | 1 00 | 100 | 0 | 0 | 1377 7 | 52 45 | 1182 9 | 1458 9 | 1377 7 | 52 45 | 1182 9 | 1458 9 | 1 01 | 0 03 | 1 00 | 1 18 | 0 00 | 0 00 | 0 00 | 0 00 |
| 89 | MULT | 1 00 | 200 | 0 | 0 | 1275 1 | 112 96 | 988 3 | 1458 9 | 1275 1 | 112 96 | 988 3 | 1458 9 | 2 16 | 1 15 | 1 00 | 5 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| 90 | MULT | 1 00 | 200 | 0 | 0 | 1275 1 | 112 96 | 988 3 | 1458 9 | 1337 8 | 124 64 | 1048 1 | 1579 4 | 2 21 | 1 21 | 1 00 | 5 00 | 0 27 | 0 30 | 0 00 | 1 13 |
| 91 | MULT | 1 00 | 200 | 0 | 0 | 1337 8 | 124 64 | 1048 1 | 1579 4 | 1345 6 | 126 45 | 1055 7 | 1597 6 | 2 12 | 1 35 | 1 00 | 5 00 | 0 28 | 0 41 | 0 00 | 1 42 |
| 92 | MULT | 1 00 | 200 | 0 | 0 | 1345 6 | 126 45 | 1055 7 | 1597 6 | 1345 6 | 126 45 | 1055 7 | 1597 6 | 2 09 | 1 33 | 1 00 | 5 00 | 0 28 | 0 41 | 0 00 | 1 42 |
| 93 | MULT | 1 00 | 242 | 42 | 0 | 1386 9 | 155 45 | 1055 7 | 1731 1 | 1397 9 | 167 64 | 1055 7 | 1770 9 | 2 51 | 1 60 | 1 00 | 5 00 | 0 41 | 0 50 | 0 00 | 1 42 |
| [illegible] | MULT | 1 00 | 200 | 0 | 0 | 1359 0 | 147 77 | 1055 7 | 1773 9 | 1359 0 | 147 77 | 1055 7 | 1778 9 | 2 13 | 1 32 | 1 00 | 5 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | MULT | 1 00 | 100 | 0 | 0 | 27 0 | 5 40 | 19 3 | 58 1 | 27 8 | 5 40 | 19 3 | 58 1 | 1 00 | 0 00 | 1 00 | 1 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | MULT | 1 00 | 100 | 0 | 0 | 27 8 | 5 40 | 19 3 | 58 1 | 58 8 | 5 42 | 50 0 | 66 6 | 1 00 | 0 00 | 1 00 | 1 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | MULT | 1 00 | 100 | 0 | 0 | 58 0 | 5 42 | 50 0 | 88 6 | 90 0 | 5 56 | 79 4 | 119 1 | 1 00 | 0 00 | 1 00 | 1 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | SING | 1 00 | 100 | 0 | 0 | 58 8 | 5 42 | 50 0 | 88 6 | 58 8 | 5 42 | 50 0 | 88 6 | 1 00 | 0 00 | 1 00 | 1 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| 97 | MULT | 1 00 | 100 | 0 | 0 | 58 8 | 5 42 | 50 0 | 88 6 | 58 8 | 5 42 | 50 0 | 98 6 | 1 00 | 0 00 | 1 00 | 1 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| 100 | MULT | 1 00 | 100 | 25 | 0 | 90 0 | 5 56 | 79 4 | 119 1 | 105 9 | 8 05 | 89 0 | 137 3 | 1 00 | 0 00 | 1 00 | 1 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| 101 | MULT | 1 00 | 100 | 0 | 0 | 105 9 | 8 05 | 89 0 | 137 3 | 105 9 | 8 05 | 89 0 | 137 3 | 1 00 | 0 00 | 1 00 | 1 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| 102 | MULT | 1 00 | 100 | 0 | 0 | 105 9 | 8 05 | 89 0 | 137 3 | 105 9 | 8 05 | 89 0 | 137 3 | 1 00 | 0 00 | 1 00 | 1 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| 123 | MULT | 1 00 | 200 | 0 | 0 | 622 1 | 194 04 | 415 2 | 834 0 | 622 1 | 194 04 | 415 2 | 834 0 | 1 51 | 0 48 | 1 01 | 2 08 | 0 00 | 0 00 | 0 00 | 0 00 |
| 124 | MULT | 1 00 | 200 | 0 | 0 | 622 1 | 194 04 | 415 2 | 834 0 | 640 2 | 189 22 | 438 3 | 847 4 | 1 51 | 0 48 | 1 01 | 2 08 | 0 10 | 0 09 | 0 00 | 0 21 |
| 125 | MULT | 1 00 | 238 | 38 | 0 | 629 1 | 187 05 | 438 3 | 847 4 | 637 3 | 179 34 | 451 5 | 847 4 | 1 48 | 0 46 | 1 01 | 2 09 | 0 09 | 0 09 | 0 00 | 0 21 |
| 126 | MULT | 1 00 | 200 | 0 | 0 | 650 0 | 179 46 | 451 5 | 847 4 | 674 1 | 173 33 | 482 8 | 865 3 | 1 42 | 0 60 | 1 00 | 2 36 | 0 17 | 0 17 | 0 00 | 0 39 |
| 127 | MULT | 1 00 | 205 | 5 | 0 | 673 5 | 173 45 | 482 8 | 868 2 | 680 0 | 180 03 | 482 8 | 881 9 | 1 48 | 0 46 | 1 00 | 2 06 | 0 09 | 0 09 | 0 00 | 0 20 |
| 128 | MULT | [illegible] | 200 | 0 | 0 | 680 8 | 180 04 | 482 [illegible] | 881 9 | 695 8 | 165 02 | 514 3 | 881 9 | 1 6[illegible] | 0 65 | 1 00 | 2 49 | 0 18 | 0 18 | 0 00 | 0 43 |
| 129 | MULT | [illegible] | 200 | 0 | 0 | 695 8 | 165 02 | 514 [illegible] | 881 9 | 695 8 | 165 02 | 514 3 | 881 9 | 1 4[illegible] | 0 46 | 1 00 | 2 05 | 0 09 | 0 09 | 0 00 | 0 20 |

Figure 4-20 #1 Leg 5 (1 of 6)

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 130 | MULT | 1.00 | 200 | 4 | 0. | 695.8 | 165.02 | 514.3 | 881.9 | 707.3 | 162.05 | 519.3 | 890.9 | 1.48 | 0.46 | 1.00 | 2.05 | 0.09 | 0.09 | 0.00 | 0.20 |
| 131 | MULT | 1.00 | 200 | 0. | 0. | 707.3 | 162.05 | 519.3 | 890.9 | 707.3 | 162.05 | 519.3 | 890.9 | 1.48 | 0.46 | 1.00 | 2.06 | 0.00 | 0.00 | 0.00 | 0.00 |
| 132 | MULT | 1.00 | 200 | 0. | 0 | 753.7 | 176.83 | 542.6 | 947.9 | 753.7 | 176.83 | 542.6 | 947.9 | 1.62 | 0.60 | 1.00 | 2.36 | 0.00 | 0.00 | 0.00 | 0.00 |
| 133 | SING | 1.00 | 200 | 0 | 0 | 753.7 | 176.83 | 542.6 | 947.9 | 787.8 | 181.10 | 574.5 | 995.8 | 1.88 | 0.86 | 1.00 | 2.96 | 0.28 | 0.28 | 0.0[illegible] | 0.66 |
| 134 | SING | 1.00 | 200 | 0. | 0. | 753.7 | 176.83 | 542.6 | 947.9 | 822.7 | 157.82 | 632.7 | 1000.6 | 1.51 | 0.50 | 1.00 | 2.18 | 0.16 | 0.16 | 0.00 | 0.38 |
| 135 | SING | 1.00 | 200 | 0 | 0. | 787.8 | 181.10 | 574.5 | 995.8 | 825.3 | 188.59 | 604.2 | 1053.1 | 1.99 | 0.97 | 1.00 | 3.31 | 0.32 | 0.32 | 0.00 | 0.79 |
| 136 | SING | 1.00 | 200 | 0 | 0. | 825.3 | 188.59 | 604.2 | 1053.1 | 948.7 | 226.31 | 694.4 | 1231.6 | 2.17 | 1.17 | 1.00 | 4.01 | 0.38 | 0.39 | 0.00 | 1.04 |
| 137 | MULT | 1.00 | 200 | 0 | 0 | 753.7 | 176.83 | 542.6 | 947.9 | 834.2 | 170.58 | 632.6 | 1057.4 | 1.75 | 0.74 | 1.00 | 2.69 | 0.26 | 0.26 | 0.00 | 0.61 |
| 138 | SING | 1.00 | 200 | 0. | 0 | 753.7 | 176.83 | 542.6 | 947.9 | 844.2 | 180.21 | 633.4 | 1066.3 | 1.81 | 0.80 | 1.00 | 2.80 | 0.28 | 0.28 | 0.00 | 0.66 |
| 139 | MULT | 1.00 | 200. | 0 | 0. | 948.7 | 226.31 | 694.4 | 1231.6 | 948.7 | 226.31 | 694.4 | 1231.6 | 2.95 | 1.97 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 140 | MULT | 1.00 | 200 | 0 | 0. | 796.7 | 72.84 | 694.4 | 890.9 | 796.7 | 72.84 | 694.4 | 890.9 | 1.22 | 0.20 | 1.00 | 1.51 | 0.00 | 0.00 | 0.00 | 0.00 |
| 141 | SING | 1.00 | 200 | 0 | 0. | 796.7 | 72.84 | 694.4 | 890.9 | 820.3 | 66.25 | 725.1 | 906.9 | 1.30 | 0.28 | 1.00 | 1.72 | 0.07 | 0.07 | 0.00 | 0.19 |
| 142 | SING | 1.00 | 200 | 0. | 0. | 796.7 | 72.84 | 694.4 | 890.9 | 871.4 | 59.16 | 784.4 | 947.9 | 1.15 | 0.14 | 1.00 | 1.34 | 0.04 | 0.04 | 0.00 | 0.10 |
| 143 | SING | 1.00 | 200 | 0 | 0. | 820.3 | 66.25 | 725.1 | 906.9 | 844.0 | 59.73 | 756.3 | 923.2 | 1.29 | 0.27 | 1.00 | 1.70 | 0.07 | 0.07 | 0.00 | 0.18 |
| 144 | SING | 1.00 | 200. | 0 | 0. | 844.0 | 59.73 | 756.3 | 923.2 | 867.8 | 53.27 | 788.5 | 939.9 | 1.28 | 0.26 | 1.00 | 1.68 | 0.07 | 0.07 | 0.00 | 0.18 |
| 145 | MULT | 1.00 | 200 | 0 | 0 | 796.7 | 72.84 | 694.4 | 890.9 | 857.6 | 55.37 | 784.3 | 940.4 | 1.22 | 0.21 | 1.00 | 1.56 | 0.06 | 0.06 | 0.00 | 0.16 |
| 146 | SING | 1.00 | 200 | 0. | 0 | 796.7 | 72.84 | 694.4 | 890.9 | 866.2 | 54.03 | 783.7 | 938.6 | 1.26 | 0.26 | 1.00 | 1.66 | 0.07 | 0.07 | 0.00 | 0.19 |
| 147 | MULT | 1.00 | 200 | 0. | 0 | 872.6 | 57.91 | 788.5 | 947.9 | 872.6 | 57.91 | 788.5 | 947.9 | 1.21 | 0.19 | 1.00 | 1.49 | 0.00 | 0.00 | 0.00 | 0.00 |

Figure 4-20 #1 Leg 5 (2 of 6)

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD | BUSY TIME MIN | BUSY TIME MAX | IDLE TIME MEAN | IDLE TIME STD | IDLE TIME MIN | IDLE TIME MAX | TOTAL TIME USED MEAN | TOTAL TIME USED STD | TOTAL TIME USED MIN | TOTAL TIME USED MAX | STRESS MEAN | STRESS STD. | STRESS MIN | STRESS MAX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1530.00 | 1370.5 | 119.6 | 1168.8 | 1676.8 | 100.4 | 3.2 | 95.1 | 112.3 | 1470.9 | 121.2 | 1263.3 | 1778.9 | 1.54 | 0.31 | 1.12 | 2.23 |
| 2 | 1530.00 | 985.8 | 129.7 | [illegible] | 1313.0 | 485.1 | 25.9 | 351.7 | 532.5 | 1470.9 | 121.2 | 1263.3 | 1778.9 | 1.27 | 0.25 | 1.05 | 1.87 |
| 3 | 1530.00 | 985.0 | 129.7 | 860.2 | 1313.0 | 485.1 | 25.9 | 351.7 | 532.5 | 1470.9 | 121.2 | 1263.3 | 1778.9 | 1.27 | 0.25 | 1.05 | 1.69 |
| 4 | 1530.00 | 1181.9 | 110.5 | 1072.4 | 1471.8 | 289.0 | 31.6 | 170.2 | 320.1 | 1470.9 | 121.2 | 1263.3 | 1778.9 | 1.35 | 0.28 | 1.07 | 2.02 |
| 5 | 1530.00 | 547.6 | 12.8 | 507.2 | 562.9 | 923.4 | 132.5 | 700.6 | 1249.2 | 1470.9 | 121.2 | 1263.3 | 1778.9 | 1.03 | 0.03 | 0.98 | 1.13 |
| 6 | 1530.00 | 115.1 | 9.0 | 84.5 | 121.7 | 1355.9 | 128.9 | 1143.7 | 1678.2 | 1470.9 | 121.2 | 1263.3 | 1778.9 | 1.00 | 0.03 | 0.96 | 1.09 |
| 7 | 1530.00 | 115.1 | 9.0 | 84.5 | 121.7 | 1355.9 | 128.9 | 1143.7 | 1678.2 | 1470.9 | 121.2 | 1263.3 | 1778.9 | 1.00 | 0.03 | 0.96 | 1.09 |

70 SUCCESSFUL MISSIONS

30 UNSUCCESSFUL MISSIONS

Figure 4-20 #1 Leg 5 (3 of 6)

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK | TASK | TASK | ---COUNTERS--- | | | ----TIME TASK REALIZED---- | | | | ----TIME TASK COMPLETED---- | | | | ----TASK STRESS---- | | | | -TASK COHESIVENESS- | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NO | TYPE | ESS | REL | FAIL | SKIP | MEAN | STD | MIN | MAX | MEAN | STD | MIN | MAX | MEAN | STD | MIN | MAX | MEAN | STD | MIN. | MAX. |
| 1 | MULT | 1.00 | 102 | 2 | 0 | 0.5 | 3.79 | 0.0 | 27.4 | 28.4 | 5.11 | 19.2 | 56.5 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | MULT | 1.00 | 101 | 1 | 0 | 28.5 | 5.73 | 19.2 | 56.5 | 28.5 | 5.13 | 19.2 | 56.5 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 3 | MULT | 1.00 | 104 | 4 | 0 | 542.9 | 11.63 | 517.0 | 568.3 | 557.4 | 13.45 | 520.3 | 584.7 | 1.02 | 0.02 | 1.00 | 1.06 | 0.00 | 0.00 | 0.00 | 0.01 |
| 4 | MULT | 1.00 | 102 | 2 | 0 | 557.9 | 13.69 | 520.3 | 584.7 | 574.1 | 14.98 | 527.3 | 604.5 | 1.02 | 0.02 | 1.00 | 1.06 | 0.00 | 0.00 | 0.00 | 0.01 |
| 5 | MULT | 1.00 | 103 | 3 | 0 | 1232.6 | 51.26 | 1049.3 | 1354.3 | 1243.4 | 50.55 | 1064.0 | 1360.8 | 1.48 | 0.68 | 1.00 | 3.22 | 0.09 | 0.13 | 0.00 | 0.42 |
| 6 | EGMI | 1.00 | 100 | 0 | 0 | 1457.2 | 107.71 | 1294.3 | 1799.2 | 1457.8 | 107.71 | 1294.3 | 1799.2 | | | | | | | | |
| 7 | MULT | 1.00 | 200 | 0 | 0 | 811.5 | 8.84 | 770.5 | 828.0 | 811.5 | 8.84 | 770.5 | 828.0 | 1.02 | 0.02 | 1.00 | 1.06 | 0.00 | 0.00 | 0.00 | 0.01 |
| 20 | MULT | 1.00 | 100 | 0 | 0 | 106.4 | 9.05 | 87.7 | 142.8 | 106.4 | 9.05 | 87.7 | 142.8 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 21 | SING | 1.00 | 100 | 0 | 0 | 106.4 | 9.05 | 87.7 | 142.8 | 137.6 | 9.00 | 118.6 | 173.5 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 22 | SING | 1.00 | 100 | 0 | 0 | 137.6 | 9.00 | 118.6 | 173.5 | 137.6 | 9.00 | 118.6 | 173.5 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 23 | MULT | 1.00 | 100 | 0 | 0 | 106.4 | 9.05 | 87.7 | 142.8 | 226.5 | 9.07 | 207.8 | 261.7 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 24 | SING | 1.00 | 100 | 0 | 0 | 106.4 | 9.05 | 87.7 | 142.8 | 226.4 | 9.12 | 207.9 | 263.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 25 | MULT | 1.00 | 100 | 0 | 0 | 226.8 | 9.08 | 207.9 | 263.6 | 226.8 | 9.08 | 207.9 | 263.6 | 1.03 | 0.01 | 1.01 | 1.07 | 0.00 | 0.00 | 0.00 | 0.00 |
| 57 | MULT | 1.00 | 100 | 0 | 0 | 226.8 | 9.08 | 207.9 | 263.6 | 226.8 | 9.08 | 207.9 | 263.6 | 1.03 | 0.01 | 1.01 | 1.07 | 0.00 | 0.00 | 0.00 | 0.00 |
| 58 | SING | 1.00 | 100 | 0 | 0 | 226.8 | 9.08 | 207.9 | 263.6 | 256.3 | 8.59 | 238.3 | 292.1 | 1.03 | 0.01 | 1.01 | 1.07 | 0.01 | 0.00 | 0.00 | 0.01 |
| 59 | SING | 1.00 | 100 | 0 | 0 | 256.3 | 8.59 | 238.3 | 292.1 | 285.8 | 8.30 | 269.2 | 320.4 | 1.03 | 0.01 | 1.01 | 1.07 | 0.01 | 0.00 | 0.00 | 0.01 |
| 60 | SING | 1.00 | 100 | 0 | 0 | 285.8 | 8.30 | 269.2 | 320.4 | 285.8 | 8.30 | 269.2 | 320.4 | 1.03 | 0.01 | 1.01 | 1.07 | 0.01 | 0.00 | 0.00 | 0.01 |
| 61 | SING | 1.00 | 100 | 0 | 0 | 226.8 | 9.08 | 207.9 | 263.6 | 372.4 | 7.69 | 356.0 | 404.8 | 1.02 | 0.01 | 1.01 | 1.05 | 0.01 | 0.00 | 0.00 | 0.01 |
| 62 | SING | 1.00 | 100 | 0 | 0 | 285.8 | 8.30 | 269.2 | 320.4 | 429.5 | 6.34 | 417.8 | 456.2 | 1.03 | 0.01 | 1.01 | 1.07 | 0.01 | 0.00 | 0.00 | 0.01 |
| 63 | SING | 1.00 | 100 | 0 | 0 | 429.5 | 6.34 | 417.8 | 456.2 | 429.5 | 6.34 | 417.8 | 456.2 | 1.03 | 0.01 | 1.01 | 1.06 | 0.00 | 0.00 | 0.00 | 0.01 |
| 64 | MULT | 1.00 | 100 | 0 | 0 | 226.8 | 9.08 | 207.9 | 263.6 | 372.3 | 7.63 | 356.1 | 401.8 | 1.02 | 0.01 | 1.01 | 1.05 | 0.01 | 0.00 | 0.00 | 0.01 |
| 65 | SING | 1.00 | 100 | 0 | 0 | 226.8 | 9.08 | 207.9 | 263.6 | 372.2 | 7.65 | 356.9 | 402.9 | 1.02 | 0.01 | 1.01 | 1.05 | 0.01 | 0.00 | 0.00 | 0.01 |
| 66 | MULT | 1.00 | 100 | 0 | 0 | 429.5 | 6.34 | 417.8 | 456.2 | 429.5 | 6.34 | 417.8 | 456.2 | 1.03 | 0.01 | 1.01 | 1.06 | 0.00 | 0.00 | 0.00 | 0.00 |
| 67 | MULT | 1.00 | 100 | 0 | 0 | 1244.2 | 51.02 | 1064.0 | 1360.8 | 1244.2 | 51.02 | 1064.0 | 1360.8 | 1.03 | 0.07 | 1.00 | 1.30 | 0.00 | 0.00 | 0.00 | 0.00 |
| 68 | MULT | 1.00 | 100 | 0 | 0 | 1244.2 | 51.02 | 1064.0 | 1360.8 | 1264.8 | 53.31 | 1076.7 | 1380.5 | 1.04 | 0.11 | 1.00 | 1.44 | 0.01 | 0.03 | 0.00 | 0.11 |
| 69 | SING | 1.00 | 100 | 0 | 0 | 1264.8 | 53.31 | 1076.7 | 1380.5 | 1294.2 | 50.58 | 1108.2 | 1398.0 | 1.04 | 0.11 | 1.00 | 1.47 | 0.01 | 0.03 | 0.00 | 0.12 |
| 70 | SING | 1.00 | 100 | 0 | 0 | 1294.2 | 50.58 | 1108.2 | 1398.0 | 1323.9 | 48.17 | 1139.6 | 1416.4 | 1.04 | 0.10 | 1.00 | 1.42 | 0.01 | 0.02 | 0.00 | 0.10 |
| 71 | SING | 1.00 | 100 | 0 | 0 | 1323.9 | 48.17 | 1139.6 | 1416.4 | 1347.1 | 46.57 | 1163.9 | 1432.1 | 1.03 | 0.08 | 1.00 | 1.35 | 0.01 | 0.02 | 0.00 | 0.09 |
| 72 | SING | 1.00 | 100 | 0 | 0 | 1347.1 | 46.57 | 1163.9 | 1432.1 | 1376.2 | 45.07 | 1192.5 | 1453.2 | 1.03 | 0.07 | 1.00 | 1.31 | 0.01 | 0.02 | 0.00 | 0.08 |
| 73 | MULT | 1.00 | 100 | 0 | 0 | 1244.2 | 51.02 | 1064.0 | 1360.8 | 1361.1 | 44.81 | 1184.8 | 1450.9 | 1.02 | 0.05 | 1.00 | 1.20 | 0.01 | 0.01 | 0.00 | 0.06 |
| 74 | MULT | 1.00 | 100 | 0 | 0 | 1376.2 | 45.07 | 1192.5 | 1453.2 | 1376.2 | 45.07 | 1192.5 | 1453.2 | 1.02 | 0.05 | 1.00 | 1.21 | 0.00 | 0.01 | 0.00 | 0.05 |
| 75 | SING | 1.00 | 100 | 0 | 0 | 1244.2 | 51.02 | 1064.0 | 1360.8 | 1359.2 | 41.64 | 1183.0 | 1436.6 | 1.04 | 0.10 | 1.00 | 1.41 | 0.01 | 0.03 | 0.00 | 0.11 |
| 76 | MULT | 1.00 | 100 | 0 | 0 | 1376.9 | 44.55 | 1192.5 | 1453.2 | 1376.9 | 44.35 | 1192.5 | 1453.2 | 1.01 | 0.02 | 1.00 | 1.10 | 0.00 | 0.00 | 0.00 | 0.00 |
| 89 | MULT | 1.00 | 200 | 0 | 0 | 1271.6 | 112.99 | 981.0 | 1453.2 | 1271.6 | 112.99 | 981.0 | 1453.2 | 2.00 | 0.95 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 90 | MULT | 1.00 | 200 | 0 | 0 | 1271.6 | 112.99 | 981.0 | 1453.2 | 1326.4 | 119.84 | 1040.6 | 1574.0 | 2.03 | 1.01 | 1.00 | 5.00 | 0.22 | 0.25 | 0.00 | 0.98 |
| 91 | MULT | 1.00 | 200 | 0 | 0 | 1326.4 | 119.84 | 1040.6 | 1574.0 | 1333.7 | 120.62 | 1049.3 | 1590.0 | 2.04 | 1.24 | 1.00 | 5.00 | 0.24 | 0.35 | 0.00 | 1.30 |
| 92 | MULT | 1.00 | 200 | 0 | 0 | 1333.7 | 120.62 | 1019.3 | 1590.0 | 1333.7 | 120.62 | 1049.3 | 1590.0 | 1.99 | 1.18 | 1.00 | 5.00 | 0.23 | 0.34 | 0.00 | 1.30 |
| 93 | MULT | 1.00 | 231 | 31 | 0 | 1371.0 | 152.80 | 1049.3 | 1760.8 | 1381.1 | 164.76 | 1049.3 | 1799.2 | 2.36 | 1.49 | 1.00 | 5.00 | 0.35 | 0.45 | 0.00 | 1.30 |
| 94 | MULT | 1.00 | 200 | 0 | 0 | 1345.4 | 140.70 | 1049.3 | 1799.2 | 1345.4 | 140.70 | 1049.3 | 1799.2 | 2.06 | 1.19 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 95 | MULT | 1.00 | 100 | 0 | 0 | 28.5 | 5.15 | 19.2 | 56.5 | 28.5 | 5.15 | 19.2 | 56.5 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 96 | MULT | 1.00 | 100 | 0 | 0 | 28.5 | 5.15 | 19.2 | 56.5 | 59.6 | 5.17 | 49.2 | 87.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 97 | MULT | 1.00 | 100 | 0 | 0 | 59.6 | 5.17 | 49.2 | 87.6 | 90.7 | 5.29 | 78.8 | 118.5 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 98 | SING | 1.00 | 100 | 0 | 0 | 59.6 | 5.17 | 49.2 | 87.6 | 59.6 | 5.17 | 49.2 | 87.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 99 | MULT | 1.00 | 100 | 0 | 0 | 59.6 | 5.17 | 49.2 | 87.6 | 59.6 | 5.17 | 49.2 | 87.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 100 | MULT | 1.00 | 100 | 3 | 0 | 90.7 | 5.29 | 78.8 | 118.5 | 106.4 | 9.05 | 87.7 | 142.8 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 101 | MULT | 1.00 | 100 | 0 | 0 | 106.4 | 9.05 | 87.7 | 142.8 | 106.4 | 9.05 | 87.7 | 142.8 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 102 | MULT | 1.00 | 100 | 0 | 0 | 106.4 | 9.05 | 87.7 | 142.8 | 106.4 | 9.05 | 87.7 | 142.8 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 123 | MULT | 1.00 | 200 | 0 | 0 | 620.5 | 191.62 | 417.8 | 828.0 | 620.5 | 191.62 | 417.8 | 828.0 | 1.49 | 0.47 | 1.01 | 2.04 | 0.00 | 0.00 | 0.00 | 0.00 |
| 124 | MULT | 1.00 | 200 | 0 | 0 | 620.5 | 191.62 | 417.8 | 828.0 | 638.6 | 186.64 | 439.7 | 841.1 | 1.49 | 0.47 | 1.01 | 2.04 | 0.09 | 0.09 | 0.00 | 0.20 |
| 125 | MULT | 1.00 | 203 | 3 | 0 | 637.8 | 186.57 | 439.7 | 841.1 | 646.0 | 178.50 | 447.[illegible] | 841.1 | 1.49 | 0.47 | 1.01 | 2.05 | 0.09 | 0.09 | 0.00 | 0.20 |
| 126 | MULT | 1.00 | 200 | 0 | 0 | 646.9 | 178.41 | 447.2 | 841.1 | 670.6 | 172.44 | 478.0 | 858.5 | 1.62 | 0.59 | 1.00 | 2.33 | 0.17 | 0.16 | 0.00 | 0.37 |
| 127 | MULT | 1.00 | 207 | 7 | 0 | 670.[illegible] | 172.69 | 478.0 | 865.0 | 676.7 | 179.25 | 478.0 | 879.1 | 1.48 | 0.46 | 1.00 | 2.06 | 0.09 | 0.09 | 0.00 | 0.20 |
| 128 | MUL[illegible] | [illegible].00 | 200 | 0 | 0 | 677.4 | 179.22 | 478.[illegible] | 879.1 | 692.3 | 164.30 | 509.3 | 879.1 | 1.6[illegible] | [illegible].64 | 1.00 | 2.49 | 0.18 | 0.18 | 0.00 | 0.43 |
| 129 | MUL[illegible] | [illegible].00 | 200 | 0 | 0 | 692.3 | 164.30 | 509.[illegible] | 879.1 | 692.3 | 164.30 | 509.3 | 879.1 | 1.4[illegible] | [illegible].45 | 1.00 | 2.05 | 0.09 | 0.09 | 0.00 | 0.20 |

Figure 4-20 #2 Leg 5 (4 of 6)

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 130 | MULT | 1.00 | 200 | 1 | 0 | 692.3 | 164.30 | 509.3 | 877.1 | 703.9 | 162.11 | 517.0 | 885.5 | 1.48 | 0.45 | 1.00 | 2.05 | 0.09 | 0.09 | 0.00 | 0.20 |
| 131 | MULT | 1.00 | 200 | 0. | 0 | 703.9 | 162.11 | 517.0 | 885.5 | 703.9 | 162.11 | 517.0 | 885.5 | 1.48 | 0.46 | 1.00 | 2.04 | 0.00 | 0.00 | 0.00 | 0.00 |
| 132 | MULT | 1.00 | 200 | 0 | 0 | 750.4 | 177.01 | 527.3 | 943.2 | 750.4 | 177.01 | 527.3 | 943.2 | 1.62 | 0.60 | 1.00 | 2.33 | 0.00 | 0.00 | 0.00 | 0.00 |
| 133 | SING | 1.00 | 200 | 0 | 0 | 750.4 | 177.01 | 527.3 | 943.2 | 784.3 | 181.02 | 559.5 | 988.2 | 1.88 | 0.86 | 1.00 | 2.92 | 0.28 | 0.28 | 0.00 | 0.65 |
| 134 | SING | 1.00 | 200 | 0 | 0 | 750.4 | 177.01 | 527.3 | 943.2 | 819.3 | 157.91 | 616.9 | 994.7 | 1.50 | 0.49 | 1.00 | 2.14 | 0.16 | 0.15 | 0.00 | 0.37 |
| 135 | SING | 1.00 | 200 | 0 | 0 | 784.3 | 181.02 | 559.5 | 988.2 | 821.3 | 188.32 | 588.7 | 1044.3 | 1.98 | 0.96 | 1.00 | 3.22 | 0.32 | 0.31 | 0.00 | 0.75 |
| 136 | SING | 1.00 | 200 | 0 | 0 | 821.3 | 188.32 | 586.7 | [illegible] | 943.6 | 224.68 | 679.0 | 1226.6 | 2.15 | 1.14 | 1.00 | 3.85 | 0.37 | 0.38 | 0.00 | 0.98 |
| 137 | MULT | 1.00 | 200 | 0 | 0 | 750.4 | 177.01 | 527.3 | 943.2 | 829.3 | 169.09 | 617.4 | 1047.2 | 1.75 | 0.74 | 1.00 | 2.66 | 0.26 | 0.26 | 0.00 | 0.60 |
| 138 | SING | 1.00 | 200 | 0 | 0 | 750.4 | 177.01 | 527.3 | 943.2 | 840.5 | 179.92 | 618.4 | 1050.1 | 1.80 | 0.79 | 1.00 | 2.77 | 0.28 | 0.28 | 0.00 | 0.65 |
| 139 | MULT | 1.00 | 200 | 0 | 0 | 943.6 | 224.68 | 679.0 | 1226.6 | 943.6 | 224.68 | 679.0 | 1226.6 | 2.97 | 1.97 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 140 | MULT | 1.00 | 200 | 0 | 0 | 793.2 | 73.06 | 679.0 | 885.5 | 793.2 | 73.06 | 679.0 | 885.5 | 1.22 | 0.20 | 1.00 | 1.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 141 | SING | 1.00 | 200 | 0 | 0 | 793.2 | 73.06 | 679.0 | 885.5 | 816.7 | 66.54 | 708.3 | 902.4 | 1.30 | 0.28 | 1.00 | 1.71 | 0.07 | 0.07 | 0.00 | 0.18 |
| 142 | SING | 1.00 | 200 | 0 | 0 | 793.2 | 73.06 | 679.0 | 885.5 | 867.9 | 59.50 | 769.1 | 943.2 | 1.15 | 0.14 | 1.00 | 1.33 | 0.04 | 0.04 | 0.00 | 0.10 |
| 143 | SING | 1.00 | 200 | 0 | 0 | 816.7 | 66.54 | 708.3 | 902.4 | 840.3 | 60.02 | 737.6 | 918.7 | 1.29 | 0.27 | 1.00 | 1.69 | 0.07 | 0.07 | 0.00 | 0.18 |
| 144 | SING | 1.00 | 200 | 0 | 0 | 840.3 | 60.02 | 737.6 | 918.7 | 864.0 | 53.59 | 769.0 | 935.9 | 1.28 | 0.26 | 1.00 | 1.67 | 0.07 | 0.07 | 0.00 | 0.17 |
| 145 | MULT | 1.00 | 200 | 0 | 0 | 793.2 | 73.06 | 679.0 | 885.5 | 864.0 | 55.55 | 769.1 | 934.8 | 1.22 | 0.21 | 1.00 | 1.55 | 0.06 | 0.06 | 0.00 | 0.16 |
| 146 | SING | 1.00 | 200 | 0 | 0 | 793.2 | 73.06 | 679.0 | 885.5 | 862.6 | 34.23 | 770.5 | 934.5 | 1.26 | 0.25 | 1.00 | 1.64 | 0.07 | 0.07 | 0.00 | 0.18 |
| 147 | MULT | 1.00 | 200 | 0 | 0 | 869.1 | 58.32 | 770.5 | 943.2 | 869.1 | 58.32 | 770.5 | 943.2 | 1.21 | 0.19 | 1.00 | 1.48 | 0.00 | 0.00 | 0.00 | 0.00 |

Figure 4-20 #2 Leg 5 (5 of 6)

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD | BUSY TIME MIN | BUSY TIME MAX | IDLE TIME MEAN | IDLE TIME STD | IDLE TIME MIN. | IDLE TIME MAX | TOTAL TIME USED MEAN | TOTAL TIME USED STD | TOTAL TIME USED MIN | TOTAL TIME USED MAX. | STRESS MEAN | STRESS STD. | STRESS MIN. | STRESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1530.00 | 1357.7 | 108.3 | 1195.7 | 1697.1 | 100.1 | 2.8 | 95.6 | 111.4 | 1457.8 | 107.7 | 1294.3 | 1799.2 | 1.48 | 0.26 | 1.12 | 2.36 |
| 2 | 1530.00 | 972.2 | 118.0 | 859.3 | 1344.5 | 485.5 | 23.3 | 352.5 | 530.2 | 1457.8 | 107.7 | 1294.3 | 1799.2 | 1.25 | 0.21 | 1.05 | 2.02 |
| 3 | 1530.00 | 972.2 | 118.0 | 859.3 | 1344.5 | 485.5 | 23.3 | 352.5 | 530.2 | 1457.8 | 107.7 | 1294.3 | 1799.2 | 1.25 | 0.21 | 1.05 | 2.02 |
| 4 | 1530.00 | 1163.2 | 100.8 | 1066.9 | 1402.7 | 294.6 | 20.6 | 173.5 | 330.7 | 1457.8 | 107.7 | 1294.3 | 1799.2 | 1.31 | 0.24 | 1.07 | 2.14 |
| 5 | 1530.00 | 549.7 | 11.3 | 515.4 | 563.4 | 908.0 | 117.2 | 730.9 | 1282.7 | 1457.8 | 107.7 | 1294.3 | 1799.2 | 1.02 | 0.03 | 0.99 | 1.12 |
| 6 | 1530.00 | 116.9 | 7.8 | 89.0 | 121.6 | 1340.8 | 114.0 | 1173.5 | 1710.2 | 1457.8 | 107.7 | 1294.3 | 1799.2 | 0.99 | 0.03 | 0.96 | 1.08 |
| 7 | 1530.00 | 116.9 | 7.8 | 89.0 | 121.6 | 1340.8 | 114.0 | 1173.5 | 1710.2 | 1457.8 | 107.7 | 1294.3 | 1799.2 | 0.99 | 0.03 | 0.96 | 1.08 |

80 SUCCESSFUL MISSIONS

20 UNSUCCESSFUL MISSIONS

Figure 4-20 #2 Leg 5 (6 of 6)

4.1.2.2 Test and Demonstration Results (Cont'd)

Table 4-6 Comparative Stress Levels (Leg 5)

| #1 Mean Stress | Operator Number | #2 Mean Stress | ΔStress |
|---|---|---|---|
| 1.54 | 1 | 1.48 | 0.06 |
| 1.29 | 2 | 1.25 | 0.04 |
| 1.29 | 3 | 1.25 | 0.04 |
| 1.36 | 4 | 1.31 | 0.05 |
| 1.03 | 5 | 1.02 | 0.01 |
| 1.00 | 6 | 0.99 | 0.01 |
| 1.00 | 7 | 0.99 | 0.01 |

The stress decreased on all operators, but especially on operators 1 to 4 (visual, right and left manual, cognitive). The configuration of #2 eliminated keyboards controlling remote CRTs (tasks 100, 125) and all of the remote readings. The cumulative effect of these tasks more than countered tasks 68 and 5, which in #1 were push buttons on an adjacent panel, but in #2 were now remote from the instructor position. Once again, operators 1 to 4 realized a lower stress on themselves which, in turn, lowered the stress on the other operators.

The tasks which exposed the differences between #1 and #2 in leg 6 of the RTP are:

| #1 Parameter Set | Task | #2 Parameter Set |
|---|---|---|
| D | 86 | C |
| A | 62 | B |
| J | 2 | K |
| A | 97 | B |
| A | 37 | B |
| G | 5 | H |
| G | 118 | H |
| F | 6 | E |
| A | 59 | B |
| G | 7 | H |
| A | 43 | B |
| G | 9 | H |
| A | 27 | B |
| A | 37 | B |

4.1.2.2 Test and Demonstration Results (Cont'd)

| #1 Parameter Set | Task | #2 Parameter Set |
|---|---|---|
| G | 11 | H |
| G | 118 | H |
| G | 12 | H |
| A | 50 | B |
| J | 13 | K |
| A | 60 | B |

The following parameters were kept constant for both #1 and #2 in leg 6 of the RTP:

| | | |
|---|---|---|
| Time allowed for mission | : | 2500.0 seconds |
| Operator speed factor | : | 1.0 |
| Operator accuracy factor | : | 1.0 |
| Operator stress threshold | : | 2.5 |

The tasks declared dormant in leg 6 of the RTP are:

| | | |
|---|---|---|
| 77 | 102 | 42 |
| 78 | 34 | 48 |
| 88 | 41 | 26 |
| 57 | 117 | 29 |
| 59 | 120 | 33 |
| 60 | 121 | 89 |
| 66 | 122 | 92 |
| 95 | 49 | 93 |
| 100 | 50 | 94 |
| 101 | 56 | 20 |
| | | 25 |

The SAINT results for the running of #1 and #2 are shown in Figure 4-21.

The Mission Summary Reports show 80 successful missions for #1, as opposed to 83 successful for #2. The Task Summary Report shows the times of completion of leg 6 of the RTP to be:

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK NO | TASK TYPE | TASK ESS | COUNTERS REL. | COUNTERS FAIL | COUNTERS SKIP | TIME TASK REALIZED MEAN | TIME TASK REALIZED STD. | TIME TASK REALIZED MIN | TIME TASK REALIZED MAX | TIME TASK COMPLETED MEAN | TIME TASK COMPLETED STD | TIME TASK COMPLETED MIN | TIME TASK COMPLETED MAX. | TASK STRESS MEAN | TASK STRESS STD | TASK STRESS MIN. | TASK STRESS MAX. | TASK COHESIVENESS MEAN | TASK COHESIVENESS STD. | TASK COHESIVENESS MIN. | TASK COHESIVENESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MULT | 1.00 | 110 | 10 | 0 | 112.9 | 9.80 | 96.0 | 156.6 | 125.2 | 15.54 | 96.0 | 173.9 | 1.02 | 0.00 | 1.01 | 1.03 | 0.01 | 0.00 | 0.00 | 0.01 |
| 2 | MULT | 1.00 | 101 | 1 | 0 | 215.1 | 14.82 | 185.5 | 259.3 | 240.9 | 15.29 | 210.8 | 286.6 | 1.03 | 0.01 | 1.01 | 1.06 | 0.01 | 0.00 | 0.00 | 0.02 |
| 3 | MULT | 1.00 | 101 | 1 | 0 | 240.6 | 15.32 | 210.8 | 286.6 | 240.6 | 15.32 | 210.8 | 286.6 | 1.03 | 0.01 | 1.01 | 1.06 | 0.01 | 0.00 | 0.00 | 0.02 |
| 4 | MULT | 1.00 | 100 | 0 | 0 | 325.7 | 13.80 | 298.4 | 366.2 | 325.7 | 13.80 | 298.4 | 366.2 | 1.07 | 0.01 | 1.05 | 1.10 | 0.02 | 0.00 | 0.01 | 0.03 |
| 5 | MULT | 1.00 | 129 | 29 | 0 | 460.2 | 13.31 | 431.5 | 502.5 | 475.2 | 14.12 | 445.8 | 515.8 | 1.09 | 0.01 | 1.07 | 1.13 | 0.03 | 0.00 | 0.02 | 0.04 |
| 6 | MULT | 1.00 | 100 | 0 | 0 | 519.6 | 16.54 | 486.3 | 565.6 | 528.2 | 16.36 | 498.0 | 570.1 | 1.11 | 0.02 | 1.08 | 1.15 | 0.03 | 0.00 | 0.02 | 0.04 |
| 7 | MULT | 1.00 | 122 | 22 | 0 | 630.2 | 16.39 | 601.6 | 675.6 | 643.2 | 16.50 | 611.8 | 690.4 | 1.14 | 0.02 | 1.11 | 1.19 | 0.04 | 0.01 | 0.03 | 0.05 |
| 8 | MULT | 1.00 | 101 | 1 | 0 | 643.4 | 16.56 | 611.8 | 690.4 | 649.9 | 16.49 | 617.6 | 697.0 | 1.14 | 0.02 | 1.11 | 1.19 | 0.04 | 0.01 | 0.03 | 0.05 |
| 9 | MULT | 1.00 | 127 | 27 | 0 | 724.1 | 15.37 | 691.7 | 766.7 | 735.9 | 15.81 | 701.1 | 783.4 | 1.20 | 0.02 | 1.16 | 1.28 | 0.06 | 0.01 | 0.05 | 0.08 |
| 10 | MULT | 1.00 | 101 | 1 | 0 | 736.3 | 15.33 | 701.1 | 783.4 | 742.0 | 16.20 | 706.9 | 789.8 | 1.21 | 0.02 | 1.16 | 1.28 | 0.06 | 0.01 | 0.05 | 0.08 |
| 11 | MULT | 1.00 | 109 | 9 | 0 | 1240.7 | 27.53 | 1180.7 | 1326.2 | 1250.0 | 27.02 | 1190.1 | 1333.1 | 2.00 | 0.00 | 2.00 | 2.00 | 0.60 | 0.22 | 0.29 | 0.76 |
| 12 | MULT | 1.00 | 113 | 13 | 0 | 1278.2 | 26.07 | 1215.2 | 1363.2 | 1287.3 | 26.45 | 1225.3 | 1376.6 | 2.00 | 0.00 | 2.00 | 2.00 | 0.57 | 0.23 | 0.29 | 0.76 |
| 13 | MULT | 1.00 | 101 | 1 | 0 | 1745.4 | 27.70 | 1682.5 | 1832.4 | 1760.1 | 28.02 | 1691.9 | 1844.9 | 2.00 | 0.00 | 2.00 | 2.00 | 0.29 | 0.00 | 0.29 | 0.29 |
| 14 | MULT | 1.00 | 120 | 20 | 0 | 2423.8 | 118.27 | 2263.6 | 2830.8 | 2441.0 | 134.80 | 2263.6 | 2879.6 | 2.86 | 1.31 | 2.00 | 5.00 | 1.28 | 1.29 | 0.32 | 3.99 |
| 15 | MULT | 1.00 | 100 | 0 | 0 | 2475.2 | 141.50 | 2307.7 | 3016.2 | 2496.0 | 153.74 | 2320.6 | 3064.6 | 2.58 | 1.18 | 2.00 | 5.00 | 1.23 | 1.64 | 0.29 | 4.57 |
| 20 | MULT | 1.00 | 100 | 0 | 0 | 2410.5 | 112.96 | 2263.6 | 2879.6 | 2410.5 | 112.96 | 2263.6 | 2879.6 | 2.86 | 0.87 | 2.50 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 21 | SING | 1.00 | 100 | 0 | 0 | 2410.5 | 112.96 | 2263.6 | 2879.6 | 2410.5 | 112.96 | 2263.6 | 2879.6 | 2.45 | 1.05 | 2.00 | 5.00 | 0.90 | 1.49 | 0.29 | 4.57 |
| 22 | SING | 1.00 | 100 | 0 | 0 | 2410.5 | 112.96 | 2263.6 | 2879.6 | 2434.7 | 126.86 | 2279.7 | 2943.9 | 2.45 | 1.05 | 2.00 | 5.00 | 0.90 | 1.49 | 0.29 | 4.57 |
| 23 | MULT | 1.00 | 100 | 0 | 0 | 2410.5 | 112.96 | 2263.6 | 2879.6 | 2459.4 | 141.27 | 2296.9 | 3000.4 | 2.51 | 1.06 | 2.00 | 5.00 | 0.93 | 1.49 | 0.29 | 4.57 |
| 24 | SING | 1.00 | 100 | 0 | 0 | 2410.5 | 112.96 | 2263.6 | 2879.6 | 2459.3 | 141.14 | 2296.8 | 2999.6 | 2.51 | 1.06 | 2.00 | 5.00 | 0.93 | 1.49 | 0.29 | 4.57 |
| 25 | MULT | 1.00 | 100 | 0 | 0 | 2459.5 | 141.20 | 2296.9 | 3000.4 | 2459.5 | 141.30 | 2296.9 | 3000.4 | 2.97 | 0.99 | 2.50 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 26 | MULT | 1.00 | 100 | 0 | 0 | 895.8 | 27.60 | 839.6 | 982.8 | 895.8 | 27.60 | 839.6 | 982.8 | 1.71 | 0.14 | 1.46 | 2.25 | 0.00 | 0.00 | 0.00 | 0.00 |
| 27 | SING | 1.00 | 100 | 0 | 0 | 895.8 | 27.60 | 839.6 | 982.8 | 913.9 | 26.62 | 859.9 | 999.6 | 1.47 | 0.09 | 1.31 | 1.83 | 0.13 | 0.03 | 0.09 | 0.24 |
| 28 | SING | 1.00 | 100 | 0 | 0 | 895.8 | 27.60 | 839.6 | 982.8 | 928.2 | 27.47 | 874.3 | 1017.3 | 1.71 | 0.14 | 1.46 | 2.25 | 0.13 | 0.03 | 0.05 | 0.24 |
| 29 | SING | 1.00 | 100 | 0 | 0 | 913.9 | 26.62 | 859.9 | 959.6 | 913.9 | 26.62 | 859.9 | 999.6 | 1.47 | 0.09 | 1.31 | 1.83 | 0.13 | 0.03 | 0.09 | 0.24 |
| 30 | SING | 1.00 | 100 | 0 | 0 | 913.9 | 26.62 | 859.9 | 999.6 | 931.8 | 25.71 | 880.2 | 1015.9 | 1.47 | 0.09 | 1.31 | 1.83 | 0.13 | 0.03 | 0.09 | 0.24 |
| 31 | MULT | 1.00 | 100 | 0 | 0 | 895.8 | 27.60 | 839.6 | 982.8 | 930.7 | 25.87 | 878.7 | 1015.1 | 1.47 | 0.09 | 1.31 | 1.83 | 0.13 | 0.03 | 0.09 | 0.24 |
| 32 | SING | 1.00 | 100 | 0 | 0 | 895.8 | 27.60 | 839.6 | 982.8 | 930.7 | 25.86 | 879.1 | 1014.8 | 1.47 | 0.09 | 1.31 | 1.83 | 0.13 | 0.03 | 0.09 | 0.24 |
| 33 | MULT | 1.00 | 100 | 0 | 0 | 931.9 | 25.83 | 880.2 | 1017.3 | 931.9 | 25.83 | 800.2 | 1017.3 | 1.71 | 0.15 | 1.46 | 2.32 | 0.00 | 0.00 | 0.00 | 0.00 |
| 34 | MULT | 1.00 | 300 | 0 | 0 | 1150.2 | 627.38 | 375.8 | 2020.6 | 1150.2 | 627.39 | 375.8 | 2020.6 | 2.93 | 1.59 | 1.10 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 35 | SING | 1.00 | 300 | 0 | 0 | 1150.2 | 627.38 | 375.8 | 2020.6 | 1246.6 | 655.98 | 426.7 | 2140.7 | 3.21 | 1.59 | 1.10 | 5.00 | 1.83 | 1.86 | 0.02 | 4.57 |
| 36 | SING | 1.00 | 300 | 0 | 0 | 1150.2 | 627.38 | 375.8 | 2020.6 | 1179.3 | 642.19 | 404.1 | 2085.9 | 3.21 | 1.62 | 1.07 | 5.00 | 1.82 | 1.84 | 0.02 | 4.57 |
| 37 | SING | 1.00 | 300 | 0 | 0 | 1179.3 | 642.19 | 404.1 | 2085.9 | 1200.2 | 640.73 | 404.1 | 2085.9 | 3.28 | 1.63 | 1.07 | 5.00 | 1.83 | 1.79 | 0.02 | 4.57 |
| 38 | MULT | 1.00 | 300 | 0 | 0 | 1150.2 | 627.38 | 375.8 | 2020.6 | 1245.7 | 652.38 | 429.6 | 2138.4 | 3.16 | 1.60 | 1.07 | 5.00 | 1.75 | 1.78 | 0.02 | 4.57 |
| 39 | SING | 1.00 | 300 | 0 | 0 | 1200.2 | 640.73 | 404.1 | 2085.9 | 1250.4 | 654.61 | 431.5 | 2143.2 | 3.29 | 1.64 | 1.07 | 5.00 | 1.93 | 1.92 | 0.02 | 4.57 |
| 40 | SING | 1.00 | 300 | 0 | 0 | 1150.2 | 627.38 | 375.8 | 2020.5 | 1247.5 | 654.41 | 430.8 | 2140.1 | 3.25 | 1.63 | 1.07 | 5.00 | 1.84 | 1.86 | 0.02 | 4.57 |
| 41 | MULT | 1.00 | 300 | 0 | 0 | 1251.2 | 655.25 | 431.5 | 2143.2 | 1251.2 | 655.25 | 431.5 | 2143.2 | 2.87 | 1.46 | 1.10 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 42 | MULT | 1.00 | 200 | 0 | 0 | 1118.7 | 470.47 | 617.6 | 1675.0 | 1110.7 | 470.47 | 617.6 | 1675.0 | 1.88 | 0.63 | 1.19 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 43 | SING | 1.00 | 200 | 0 | 0 | 1118.7 | 470.47 | 617.6 | 1675.0 | 1139.9 | 467.36 | 642.0 | 1693.4 | 1.71 | 0.54 | 1.12 | 2.37 | 0.22 | 0.18 | 0.04 | 0.46 |
| 44 | SING | 1.00 | 200 | 0 | 0 | 1118.7 | 470.47 | 617.6 | 1675.0 | 1199.8 | 509.42 | 663.3 | 1795.0 | 2.38 | 1.13 | 1.19 | 3.50 | 0.52 | 0.48 | 0.04 | 1.00 |
| 45 | MULT | 1.00 | 200 | 0 | 0 | 1118.7 | 470.47 | 617.6 | 1675.0 | 1159.4 | 464.28 | 667.4 | 1710.2 | 1.68 | 0.51 | 1.12 | 2.31 | 0.21 | 0.16 | 0.04 | 0.43 |
| 46 | SING | 1.00 | 200 | 0 | 0 | 1139.9 | 467.36 | 642.0 | 1693.4 | 1180.8 | 461.27 | 691.7 | 1728.4 | 1.70 | 0.53 | 1.12 | 2.37 | 0.22 | 0.18 | 0.04 | 0.46 |
| 47 | SING | 1.00 | 200 | 0 | 0 | 1118.7 | 470.47 | 617.6 | 1675.0 | 1159.6 | 464.45 | 667.1 | 1707.8 | 1.73 | 0.56 | 1.12 | 2.42 | 0.24 | 0.19 | 0.04 | 0.49 |
| 48 | MULT | 1.00 | 200 | 0 | 0 | 1214.3 | 494.84 | 691.7 | 1795.0 | 1214.3 | 494.84 | 691.7 | 1795.0 | 1.90 | 0.60 | 1.24 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 49 | MULT | 1.00 | 200 | 0 | 0 | 932.2 | 356.92 | 547.7 | 1376.6 | 932.2 | 356.92 | 547.7 | 1376.6 | 1.93 | 0.84 | 1.15 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 50 | SING | 1.00 | 200 | 0 | 0 | 932.2 | 356.92 | 547.7 | 1376.6 | 940.9 | 365.62 | 547.7 | 1393.7 | 1.58 | 0.44 | 1.10 | 2.09 | 0.18 | 0.16 | 0.03 | 0.76 |
| 51 | SING | 1.00 | 200 | 0 | 0 | 932.2 | 356.92 | 547.7 | 1376.6 | 1014.5 | 394.53 | 595.9 | 1496.7 | 2.40 | 1.22 | 1.15 | 5.00 | 0.63 | 0.84 | 0.03 | 4.57 |
| 52 | SING | 1.00 | 200 | 0 | 0 | 940.9 | 365.62 | 547.7 | 1393.7 | 962.1 | 361.62 | 574.4 | 1411.1 | 1.58 | 0.45 | 1.10 | 2.11 | 0.16 | 0.16 | 0.03 | 0.76 |
| 53 | MULT | 1.00 | 200 | 0 | 0 | 932.2 | 356.92 | 547.7 | 1376.6 | 973.3 | 349.06 | 599.0 | 1410.1 | 1.57 | 0.43 | 1.10 | 2.04 | 0.18 | 0.16 | 0.03 | 0.76 |
| 54 | SING | 1.00 | 200 | 0 | 0 | 762.1 | 361.62 | 574.4 | 1411.1 | 983.4 | 357.60 | 601.6 | 1427.2 | 1.58 | 0.44 | 1.10 | 2.10 | 0.18 | 0.16 | 0.03 | 0.76 |
| 55 | SING | 1.00 | 200 | 0 | 0 | 932.2 | 356.92 | 547.7 | 1376.6 | 973.5 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 2.13 | 0.19 | 0.17 | 0.03 | 0.77 |
| 56 | MULT | 1.00 | 200 | 0 | 0 | 1017.5 | 391.56 | 601.6 | 1496.7 | 1017.5 | [illegible] | [illegible] | 1496.7 | 1.85 | 0.65 | 1.16 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 57 | MULT | 1.00 | 500 | 0 | 0 | 975.4 | 683.40 | 96.0 | 2143.2 | 975.4 | [illegible] | [illegible] | 2143.2 | [illegible] | [illegible] | [illegible] | 4.88 | 0.00 | 0.00 | 0.00 | 0.00 |
| 58 | SING | 1.00 | 500 | 0 | 0 | 975.4 | 683.40 | 96.0 | 2143.2 | 1011.4 | 694.82 | 124.4 | 2204.4 | 2.58 | 1.27 | 1.01 | 5.00 | 0.83 | 0.98 | 0.00 | 4.18 |



Figure 4-21 #1 Leg 6 (1 of 6)

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 59 | SING | 1 00 | 500 | 0 | 0 | 1011 4 | 694 82 | 124 4 | 2204 4 | 1014 7 | 692 60 | 124 4 | 2204 4 | 2 65 | 1 35 | 1 01 | 5 00 | 0.92 | 1 15 | 0.00 | 4.46 |
| 60 | SING | 1 00 | 500 | 0 | 0 | 1014 7 | 692 60 | 124 4 | 2204 4 | 1027 2 | 712 70 | 124 4 | 2269 6 | 2 66 | 1 34 | 1 01 | 5 00 | 0.93 | 1 15 | 0.00 | 4.46 |
| 61 | SING | 1 00 | 500 | 0 | 0 | 975 4 | 683 40 | 96 0 | 2143 2 | 1101 4 | 727 84 | 184 0 | 2320 5 | 2 62 | 1.02 | 1 01 | 4 28 | 0.75 | 0.66 | 0.00 | 2.86 |
| 62 | SING | 1 00 | 500 | 0 | 0 | 1027 2 | 712 70 | 124 4 | 2269 6 | 1042 4 | 702 59 | 155.2 | 2269 6 | 2 66 | 1 35 | 1 01 | 5.00 | 1 01 | 1.29 | 0.00 | 4 46 |
| 63 | SING | 1 00 | 500 | 0 | 0. | 1042 4 | 702 59 | 155.2 | 2269 6 | 1048 3 | 695.40 | 185.5 | 2269 6 | 2 68 | 1 37 | 1 01 | 5.00 | 1 01 | 1.28 | 0.00 | 4.46 |
| 64 | MULT | 1 00 | 500 | 0 | 0 | 975 4 | 683 40 | 96 0 | 2143 2 | 1073 5 | 714 66 | 183.9 | 2323 0 | 2 52 | 1 24 | 1.01 | 5 00 | 0 79 | 0 95 | 0.00 | 4.02 |
| 65 | SING | 1 00 | 500 | 0 | 0 | 975 4 | 683 40 | 96 0 | 2143.2 | 1082 7 | 717.95 | 184 4 | 2323 6 | 2.62 | 1 30 | 1 01 | 5.00 | 0 84 | 0.98 | 0.00 | 4.18 |
| 66 | MULT | 1 00 | 500 | 0 | 0 | 1102 9 | 727 16 | 185 5 | 2323 6 | 1102 9 | 727.16 | 185 5 | 2323.6 | 2 64 | 1.38 | 1.02 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 77 | MULT | 1 00 | 100 | 0 | 0 | 0 0 | 0 00 | 0 0 | 0 0 | 0.0 | 0.00 | 0.0 | 0 0 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0 00 | 0.00 | 0.00 |
| 78 | MULT | 1 00 | 103 | 3 | 0 | 0 0 | 0 00 | 0 0 | 0 0 | 0 0 | 0 00 | 0.0 | 0 0 | 1 00 | 0 00 | 1.00 | 1 00 | 0.00 | 0 00 | 0.00 | 0.00 |
| 79 | MULT | 1.00 | 100 | 0 | 0. | 0 0 | 0 00 | 0.0 | 0 0 | 31 0 | 1.00 | 28.6 | 32.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 80 | MULT | 1 00 | 103 | 3 | 0 | 31 2 | 1 72 | 28 6 | 42 7 | 43 0 | 6 68 | 29.4 | 61 2 | 1 00 | 0 00 | 1 00 | 1 00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 81 | MULT | 1 00 | 100 | 0 | 0 | 43 1 | 6 71 | 29 4 | 61 2 | 53 7 | 8 06 | 37 2 | 76 2 | 1 00 | 0 00 | 1 00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 82 | MULT | 1 00 | 100 | 0 | 0 | 53 7 | 8 06 | 37 2 | 76 2 | 111 1 | 7.46 | 96 0 | 131 7 | 1.03 | 0 01 | 1.02 | 1 05 | 0.01 | 0.00 | 0.00 | 0.01 |
| 83 | MULT | 1 00 | 100 | 0 | 0 | 53 7 | 8 06 | 37 2 | 76 2 | 63.4 | 8 34 | 41 9 | 82.2 | 1 02 | 0 00 | 1.01 | 1 03 | 0.01 | 0 00 | 0.0C | 0.01 |
| 84 | MULT | 1 00 | 103 | 3 | 0 | 63 6 | 8 29 | 41 9 | 82 2 | 75 0 | 9 93 | 48 5 | 97.3 | 1 02 | 0 00 | 1.01 | 1.03 | 0.01 | 0 00 | 0 00 | 0.01 |
| 85 | MULT | 1 00 | 100 | 0 | 0 | 75 2 | 10 01 | 48 5 | 97 3 | 84.9 | 10 55 | 56.8 | 112 8 | 1 02 | 0.00 | 1.01 | 1.03 | 0.01 | 0.00 | 0.00 | 0.01 |
| 86 | MULT | 1 00 | 100 | 0 | 0 | 84 9 | 10 55 | 56 8 | 112.8 | 96 4 | 12 68 | 58 5 | 125 2 | 1 02 | 0.00 | 1.01 | 1.03 | 0.01 | 0.00 | 0.00 | 0.01 |
| 88 | MULT | 1 00 | 100 | 0 | 0 | 111 5 | 7 70 | 96.0 | 131 7 | 111.5 | 7.70 | 96.0 | 131.7 | 1.03 | 0.01 | 1.01 | 1.05 | 0.C0 | 0.00 | 0.00 | 0.00 |
| 89 | MULT | 1 00 | 200 | 0 | 0 | 2083 4 | 390 39 | 1645 6 | 3000 4 | 2083 4 | 390 39 | 1645.6 | 3000 4 | 3.49 | 1 12 | 2 50 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 90 | MULT | 1 00 | 200 | 0 | 0 | 2083 4 | 390 39 | 1645 6 | 3000.4 | 2100 1 | 374.32 | 1678.6 | 3000.4 | 3.41 | 1 44 | 2.00 | 5.00 | 1.49 | 1.49 | 0.29 | 4.57 |
| 91 | MULT | 1 00 | 200 | 0 | 0 | 2100 1 | 374 32 | 1678 6 | 3000 4 | 2110.1 | 379.85 | 1682.5 | 3016 2 | 3.34 | 1 39 | 2.00 | 5.00 | 1.44 | 1.49 | 0.29 | 4.57 |
| 92 | MULT | 1 00 | 200 | C | 0 | 2110 1 | 379 85 | 1682 5 | 3016 2 | 2110.1 | 379.85 | 1682.5 | 3016.2 | 3 40 | 1.43 | 2.00 | 5.00 | 1.49 | 1.49 | 0.29 | 4.57 |
| 93 | MULT | 1 00 | 200 | 0 | 0 | 2110 1 | 379 85 | 1682 5 | 3016 2 | 2110 1 | 379 85 | 1682.5 | 3016.2 | 3 40 | 1 43 | 2 00 | 5.00 | 1 49 | 1.49 | 0.29 | 4.57 |
| 94 | MULT | 1 00 | 200 | 0 | 0 | 2110 1 | 379 85 | 1682 5 | 3016.2 | 2110.1 | 379 85 | 1682 5 | 3016.2 | 3.46 | 1.12 | 2 50 | 5.00 | 0 00 | 0.00 | 0.00 | 0.00 |
| 95 | MULT | 1 00 | 400 | 0 | 0. | 814 5 | 608 51 | 210 8 | 1844 9 | 814.5 | 608.51 | 210 8 | 1844 9 | 2 04 | 0.99 | 1 04 | 4.65 | 0.00 | 0.00 | 0.00 | 0.00 |
| 96 | MULT | 1 00 | 400 | 0 | 0. | 814.5 | 608 51 | 210.8 | 1844 9 | 857.1 | 620.14 | 240.5 | 1903.1 | 2.26 | 1.20 | 1.03 | 4.62 | 0.62 | 0.66 | 0.01 | 3.01 |
| 97 | MULT | 1 00 | 400 | 0 | 0. | 857 1 | 620 14 | 240 5 | 1903.1 | 900.9 | 633.43 | 270 5 | 1966.1 | 2.42 | 1.39 | 1.03 | 5.00 | 0.72 | 0 81 | 0.01 | 3.97 |
| 98 | SING | 1 00 | 400 | 0 | 0 | 857 1 | 620 14 | 240 5 | 1903.1 | 941.1 | 651 94 | 294.5 | 2020.6 | 2.69 | 1 62 | 1.07 | 5.00 | 0.87 | 1.02 | 0.01 | 4.29 |
| 99 | MULT | 1 00 | 400 | 0 | 0 | 857 1 | 620 14 | 240 5 | 1903 1 | 922.1 | 645.26 | 298 4 | 2018.9 | 1.92 | 0.99 | 1.03 | 3.50 | 0.38 | 0.41 | 0.01 | 1.08 |
| 100 | MULT | 1 00 | 400 | 0 | 0 | 900 9 | 633 43 | 270 5 | 1966.1 | 900.9 | 633.43 | 270.5 | 1966.1 | 2 63 | 1 61 | 1.05 | 5.00 | 1.05 | 1.33 | 0.01 | 4.57 |
| 101 | MULT | 1 00 | 400 | 0 | 0 | 900 9 | 633 43 | 270 5 | 1966.1 | 900 9 | 633 43 | 270 5 | 1966 1 | 2.63 | 1.61 | 1 05 | 5.00 | 1.05 | 1.33 | 0.01 | 4.57 |
| 102 | MULT | 1 00 | 400 | 0 | 0 | 944 0 | 650 22 | 298.4 | 2020.6 | 944.0 | 650 22 | 298 4 | 2020.6 | 2.52 | 1 58 | 1.07 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 117 | MULT | 1 00 | 400 | 0. | 0 | 1176 7 | 674 90 | 445 8 | 2323 6 | 1176.7 | 674 90 | 445.8 | 2323.6 | 2 96 | 1.67 | 1.12 | 5.00 | 0.00 | 0.00 | 0.0C | 0.00 |
| 118 | MULT | 1 00 | 602 | 202. | 0. | 1454 4 | 774 40 | 445.8 | 2592.3 | 1473.6 | 786.27 | 460.1 | 2626.9 | 3.11 | 1.69 | 1.08 | 5.00 | 1.52 | 1.44 | 0.02 | 4.57 |
| 119 | MULT | 1 00 | 400 | 0 | 0 | 1205 7 | 706 58 | 460.1 | 2626.9 | 1236.3 | 722.30 | 486.3 | 2692 1 | 2.49 | 1 50 | 1.08 | 5.00 | 1.35 | 1.83 | 0.02 | 4.57 |
| 120 | MULT | 1 00 | 494 | 94 | 0 | 1450 3 | 790 83 | 486.3 | 2692 1 | 1450.3 | 790.83 | 486.3 | 2692 1 | 2 95 | 1 67 | 1.08 | 5.00 | 1 40 | 1.43 | 0.02 | 4.57 |
| 121 | MULT | 1 00 | 400 | 0 | 0 | 1236 3 | 722 30 | 486.3 | 2692 1 | 1236.3 | 722 30 | 486.3 | 2692.1 | 2 48 | 1.50 | 1.06 | 5.00 | 1.37 | 1.87 | 0.02 | 4.57 |
| 122 | MULT | 1 00 | 400 | 0 | 0 | 1236 3 | 722 30 | 486 3 | 2692 1 | 1236.3 | 722.30 | 486.3 | 2692.1 | 2 48 | 1.50 | 1.08 | 5.00 | 1.01 | 1.28 | 0.02 | 4.57 |

Figure 4-21 #1 Leg 6 (2 of 6)

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME | | | | IDLE TIME | | | | TOTAL TIME USED | | | | STRESS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MEAN | STD. | MIN. | MAX. | MEAN | STD. | MIN. | MAX. | MEAN | STD | MIN | MAX. | MEAN | STD. | MIN. | MAX. |
| 1 | 2500 00 | 1873.2 | 137 8 | 1703.8 | 2402.1 | 622.8 | 24.7 | 580.5 | 705.8 | 2496 0 | 153.7 | 2320.6 | 3064.6 | 2.19 | 0.19 | 1.90 | 2.79 |
| 2 | 2500.00 | 1823.2 | 158 7 | 1648.2 | 2378.4 | 672.7 | 27 7 | 614.8 | 725.6 | 2496 0 | 153.7 | 2320.6 | 3064.6 | 2.08 | 0.21 | 1.77 | 2.70 |
| 3 | 2500 00 | 1823 2 | 158 7 | 1648 2 | 2378.4 | 672 7 | 27 7 | 614.8 | 725.6 | 2496.0 | 153.7 | 2320.6 | 3064.6 | 2.08 | 0.21 | 1.77 | 2.70 |
| 4 | 2500 00 | 1997 6 | 154 2 | 1834 4 | 2577 9 | 498 4 | 13.8 | 460.5 | 535.4 | 2496 0 | 153 7 | 2320.6 | 3064.6 | 2.19 | 0.20 | 1.89 | 2.79 |
| 5 | 2500 00 | 1672.4 | 10 4 | 1654.2 | 1703.6 | 802 8 | 141 7 | 646.7 | 1348.8 | 2475.2 | 141.5 | 2307.7 | 3016.2 | 2.43 | 0.10 | 2.33 | 2.78 |
| 6 | 2500.00 | 317.4 | 2 9 | 309.2 | 323.3 | 2157.8 | 141.9 | 1990.4 | 2702.8 | 2475.2 | 141.5 | 2307.7 | 3016.2 | 1.79 | 0.08 | 1.71 | 2.02 |
| 7 | 2500 00 | 317 4 | 2 9 | 309 2 | 323.3 | 2157.8 | 141.9 | 1990.4 | 2702.8 | 2475 2 | 141 5 | 2307.7 | 3016.2 | 1.79 | 0.08 | 1.71 | 2.02 |

80 SUCCESSFUL MISSIONS

20 UNSUCCESSFUL MISSIONS

Figure 4-21 #1 Leg 6 (3 of 6)

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK NO | TASK TYPE | TASK ESS | COUNTERS REL | COUNTERS FAIL | COUNTERS SKIP | TIME TASK REALIZED MEAN | STD | MIN | MAX. | TIME TASK COMPLETED MEAN | STD | MIN | MAX | TASK STRESS MEAN | STD | MIN | MAX | TASK COHESIVENESS MEAN | STD | MIN | MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MULT | 1.00 | 114 | 14 | 0 | 115.2 | 10.66 | 92.9 | 146.3 | 128.9 | 14.61 | 97.7 | 168.9 | 1.02 | 0.01 | 1.01 | 1.04 | 0.01 | 0.00 | 0.00 | 0.01 |
| 2 | MULT | 1.00 | 107 | 7 | 0 | 220.8 | 15.48 | 190.9 | 274.8 | 247.8 | 16.03 | 215.8 | 299.4 | 1.03 | 0.01 | 1.01 | 1.06 | 0.01 | 0.00 | 0.00 | 0.02 |
| 3 | MULT | 1.00 | 100 | 0 | 0 | 247.3 | 15.94 | 215.8 | 299.4 | 247.3 | 15.94 | 215.8 | 299.4 | 1.03 | 0.01 | 1.01 | 1.06 | 0.01 | 0.00 | 0.00 | 0.02 |
| 4 | MULT | 1.00 | 100 | 0 | 0 | 331.7 | 14.44 | 302.3 | 380.8 | 331.7 | 14.44 | 302.3 | 380.8 | 1.07 | 0.01 | 1.03 | 1.12 | 0.02 | 0.00 | 0.01 | 0.03 |
| 5 | MULT | 1.00 | 104 | 4 | 0 | 462.7 | 13.39 | 436.0 | 513.5 | 477.1 | 14.88 | 448.0 | 521.5 | 1.10 | 0.01 | 1.07 | 1.14 | 0.03 | 0.00 | 0.02 | 0.04 |
| 6 | MULT | 1.00 | 111 | 11 | 0 | 517.1 | 17.58 | 487.0 | 576.4 | 527.7 | 21.17 | 487.0 | 600.0 | 1.11 | 0.01 | 1.08 | 1.16 | 0.03 | 0.00 | 0.02 | 0.05 |
| 7 | MULT | 1.00 | 101 | 1 | 0 | 627.5 | 18.85 | 590.6 | 697.4 | 640.4 | 19.92 | 590.6 | 710.7 | 1.14 | 0.02 | 1.09 | 1.24 | 0.04 | 0.01 | 0.03 | 0.07 |
| 8 | MULT | 1.00 | 100 | 0 | 0 | 640.1 | 19.77 | 590.6 | 710.7 | 646.7 | 19.53 | 598.5 | 717.3 | 1.14 | 0.02 | 1.09 | 1.24 | 0.04 | 0.01 | 0.03 | 0.07 |
| 9 | MULT | 1.00 | 101 | 1 | 0 | 718.6 | 17.22 | 678.3 | 779.5 | 730.4 | 17.85 | 695.1 | 796.1 | 1.20 | 0.03 | 1.14 | 1.31 | 0.06 | 0.01 | 0.04 | 0.09 |
| 10 | MULT | 1.00 | 102 | 2 | 0 | 730.2 | 17.67 | 695.1 | 796.1 | 735.0 | 17.52 | 702.4 | 801.9 | 1.20 | 0.03 | 1.14 | 1.31 | 0.06 | 0.01 | 0.04 | 0.09 |
| 11 | MULT | 1.00 | 102 | 2 | 0 | 1225.5 | 30.13 | 1163.8 | 1338.6 | 1234.7 | 30.94 | 1170.6 | 1352.8 | 2.00 | 0.00 | 2.00 | 2.00 | 0.70 | 0.16 | 0.29 | 0.76 |
| 12 | MULT | 1.00 | 100 | 0 | 0 | 1262.0 | 31.52 | 1194.8 | 1389.7 | 1271.0 | [illegible].10 | 1202.0 | 1399.8 | 2.00 | 0.00 | 2.00 | 2.00 | 0.63 | 0.21 | 0.29 | 0.76 |
| 13 | MULT | 1.00 | 103 | 3 | 0 | 1729.4 | 32.05 | 1664.0 | 1855.2 | 1745.3 | 32.25 | 1681.7 | 1869.9 | 2.00 | 0.00 | 2.00 | 2.00 | 0.29 | 0.00 | 0.29 | 0.29 |
| 14 | MULT | 1.00 | 142 | 42 | 0 | 2401.3 | 123.98 | 2233.5 | 2727.3 | 2417.3 | 131.65 | 2248.1 | 2727.3 | 2.90 | 1.31 | 2.00 | 5.00 | 1.20 | 1.18 | 0.30 | 4.57 |
| 15 | MULT | 1.00 | 100 | 0 | 0 | 2437.4 | 125.20 | 2298.2 | 2858.9 | 2457.3 | 137.44 | 2312.6 | 2913.8 | 2.49 | 1.10 | 2.00 | 5.00 | 1.04 | 1.56 | 0.29 | 4.57 |
| 20 | MULT | 1.00 | 100 | 0 | 0 | 2375.8 | 97.86 | 2253.5 | 2720.0 | 2375.8 | 97.86 | 2253.5 | 2720.0 | 2.81 | 0.82 | 2.50 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 21 | SING | 1.00 | 100 | 0 | 0 | 2375.8 | 97.86 | 2253.5 | 2720.0 | 2375.8 | 97.86 | 2253.5 | 2720.0 | 2.39 | 0.98 | 2.00 | 5.00 | 0.82 | 1.40 | 0.29 | 4.57 |
| 22 | SING | 1.00 | 100 | 0 | 0 | 2375.8 | 97.86 | 2253.5 | 2720.0 | 2399.2 | 111.20 | 2269.4 | 2782.6 | 2.39 | 0.98 | 2.00 | 5.00 | 0.82 | 1.40 | 0.29 | 4.57 |
| 23 | MULT | 1.00 | 100 | 0 | 0 | 2375.8 | 97.86 | 2253.5 | 2720.0 | 2422.2 | 124.89 | 2286.6 | 2840.4 | 2.43 | 1.01 | 2.00 | 5.00 | 0.84 | 1.40 | 0.29 | 4.57 |
| 24 | SING | 1.00 | 100 | 0 | 0 | 2375.8 | 97.86 | 2253.5 | 2720.0 | 2422.1 | 124.82 | 2286.6 | 2838.9 | 2.43 | 1.01 | 2.00 | 5.00 | 0.84 | 1.40 | 0.29 | 4.57 |
| 25 | MULT | 1.00 | 100 | 0 | 0 | 2422.3 | 125.03 | 2286.6 | 2840.4 | 2422.3 | 125.03 | 2286.6 | 2840.4 | 2.90 | 0.92 | 2.50 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 26 | MULT | 1.00 | 100 | 0 | 0 | 883.8 | 29.56 | 828.2 | 998.7 | 883.8 | 29.56 | 828.2 | 998.7 | 1.65 | 0.15 | 1.42 | 2.39 | 0.00 | 0.00 | 0.00 | 0.00 |
| 27 | SING | 1.00 | 100 | 0 | 0 | 883.8 | 29.56 | 828.2 | 998.7 | 902.3 | 28.60 | 849.4 | 1015.6 | 1.44 | 0.10 | 1.28 | 1.93 | 0.12 | 0.03 | 0.08 | 0.26 |
| 28 | SING | 1.00 | 100 | 0 | 0 | 883.8 | 29.56 | 828.2 | 998.7 | 916.5 | 29.22 | 864.1 | 1033.6 | 1.65 | 0.15 | 1.42 | 2.39 | 0.12 | 0.03 | 0.08 | 0.26 |
| 29 | SING | 1.00 | 100 | 0 | 0 | 902.3 | 28.60 | 849.4 | 1015.6 | 902.3 | 28.60 | 849.4 | 1015.6 | 1.44 | 0.10 | 1.28 | 1.93 | 0.12 | 0.03 | 0.08 | 0.26 |
| 30 | SING | 1.00 | 100 | 0 | 0 | 902.3 | 28.60 | 849.4 | 1015.6 | 920.7 | 27.75 | 869.7 | 1032.6 | 1.44 | 0.10 | 1.28 | 1.93 | 0.12 | 0.03 | 0.08 | 0.26 |
| 31 | MULT | 1.00 | 100 | 0 | 0 | 883.8 | 29.56 | 828.2 | 998.7 | 919.5 | 27.68 | 869.0 | 1031.3 | 1.44 | 0.10 | 1.28 | 1.93 | 0.12 | 0.03 | 0.08 | 0.26 |
| 32 | SING | 1.00 | 100 | 0 | 0 | 883.8 | 29.56 | 828.2 | 998.7 | 919.5 | 27.68 | 869.0 | 1031.4 | 1.44 | 0.10 | 1.28 | 1.93 | 0.12 | 0.03 | 0.08 | 0.26 |
| 33 | MULT | 1.00 | 100 | 0 | 0 | 920.8 | 27.81 | 869.7 | 1033.6 | 920.8 | 27.81 | 869.7 | 1033.6 | 1.66 | 0.16 | 1.42 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 34 | MULT | 1.00 | 300 | 0 | 0 | 1141.7 | 618.16 | 381.3 | 2049.6 | 1141.7 | 618.16 | 381.3 | 2049.6 | 2.90 | 1.59 | 1.11 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 35 | SING | 1.00 | 300 | 0 | 0 | 1141.7 | 618.16 | 381.3 | 2049.6 | 1238.0 | 646.74 | 431.2 | 2170.7 | 3.21 | 1.59 | 1.11 | 5.00 | 1.72 | 1.75 | 0.02 | 4.57 |
| 36 | SING | 1.00 | 300 | 0 | 0 | 1141.7 | 618.16 | 381.3 | 2049.6 | 1169.9 | 632.08 | 408.1 | 2115.7 | 3.14 | 1.59 | 1.07 | 5.00 | 1.68 | 1.73 | 0.02 | 4.57 |
| 37 | SING | 1.00 | 300 | 0 | 0 | 1169.9 | 632.08 | 408.1 | 2115.7 | 1190.7 | 630.48 | 408.1 | 2115.7 | 3.20 | 1.59 | 1.07 | 5.00 | 1.67 | 1.66 | 0.02 | 4.57 |
| 38 | MULT | 1.00 | 300 | 0 | 0 | 1141.7 | 618.16 | 381.3 | 2049.6 | 1235.1 | 640.62 | 435.5 | 2172.3 | 3.08 | 1.55 | 1.07 | 5.00 | 1.59 | 1.65 | 0.02 | 4.57 |
| 37 | SING | 1.00 | 300 | 0 | 0 | 1190.7 | 630.48 | 408.1 | 2115.7 | 1240.5 | 644.01 | 436.0 | 2179.2 | 3.22 | 1.62 | 1.07 | 5.00 | 1.87 | 1.92 | 0.02 | 4.57 |
| 40 | SING | 1.00 | 300 | 0 | 0 | 1141.7 | 618.16 | 381.3 | 2049.6 | 1238.0 | 644.13 | 435.1 | 2168.6 | 3.19 | 1.60 | 1.07 | 5.00 | 1.71 | 1.76 | 0.02 | 4.57 |
| 41 | MULT | 1.00 | 300 | 0 | 0 | 1242.0 | 645.40 | 436.0 | 2179.2 | 1242.0 | 645.40 | 436.0 | 2179.2 | 2.95 | 1.53 | 1.11 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 42 | MULT | 1.00 | 200 | 0 | 0 | 1108.8 | 464.07 | 598.5 | 1697.8 | 1108.8 | 464.07 | 598.5 | 1697.8 | 1.87 | 0.63 | 1.15 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 43 | SING | 1.00 | 200 | 0 | 0 | 1108.8 | 464.07 | 598.5 | 1697.8 | 1129.9 | 460.70 | 626.2 | 1715.3 | 1.68 | 0.52 | 1.10 | 2.38 | 0.21 | 0.17 | 0.03 | 0.47 |
| 44 | SING | 1.00 | 200 | 0 | 0 | 1108.8 | 464.07 | 598.5 | 1697.8 | 1190.1 | 502.81 | 646.1 | 1818.1 | 2.37 | 1.13 | 1.15 | 3.50 | 0.52 | 0.48 | 0.03 | 1.00 |
| 45 | MULT | 1.00 | 200 | 0 | 0 | 1108.8 | 464.07 | 598.5 | 1697.8 | 1149.6 | 457.59 | 650.2 | 1732.8 | 1.65 | 0.49 | 1.10 | 2.32 | 0.20 | 0.15 | 0.03 | 0.44 |
| 46 | SING | 1.00 | 200 | 0 | 0 | 1129.9 | 460.70 | 626.2 | 1715.3 | 1170.8 | 454.37 | 678.3 | 1750.1 | 1.67 | 0.51 | 1.10 | 2.37 | 0.21 | 0.16 | 0.03 | 0.46 |
| 47 | SING | 1.00 | 200 | 0 | 0 | 1108.8 | 464.07 | 598.5 | 1697.8 | 1149.8 | 457.84 | 650.1 | 1732.5 | 1.70 | 0.54 | 1.10 | 2.44 | 0.22 | 0.18 | 0.03 | 0.49 |
| 48 | MULT | 1.00 | 200 | 0 | 0 | 1204.6 | 488.25 | 678.3 | 1818.1 | 1204.6 | 488.25 | 678.3 | 1818.1 | 1.90 | 0.60 | 1.21 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 49 | MULT | 1.00 | 200 | 0 | 0 | 923.6 | 349.24 | 537.9 | 1399.8 | 923.6 | 349.24 | 537.9 | 1399.8 | 2.20 | 1.28 | 1.14 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 50 | SING | 1.00 | 200 | 0 | 0 | 923.6 | 349.24 | 537.9 | 1399.8 | 932.2 | 357.82 | 537.9 | 1417.3 | 1.57 | 0.43 | 1.09 | 2.09 | 0.23 | 0.24 | 0.03 | 0.76 |
| 51 | SING | 1.00 | 200 | 0 | 0 | 923.6 | 349.24 | 537.9 | 1399.8 | 1006.0 | 386.79 | 586.6 | 1519.5 | 2.56 | 1.44 | 1.14 | 5.00 | 0.98 | 1.43 | 0.03 | 4.57 |
| 52 | SING | 1.00 | 200 | 0 | 0 | 932.2 | 357.82 | 537.9 | 1417.3 | 953.5 | 353.68 | 564.6 | 1435.9 | 1.57 | 0.44 | 1.09 | 2.10 | 0.23 | 0.24 | 0.03 | 0.76 |
| 53 | MULT | 1.00 | 200 | 0 | 0 | 923.6 | 349.24 | 537.9 | 1399.8 | 964.7 | 341.35 | 589.8 | 1433.3 | 1.57 | 0.43 | 1.09 | 2.04 | 0.23 | 0.24 | 0.03 | 0.76 |
| 54 | SING | 1.00 | 200 | 0 | 0 | 953.5 | 353.68 | 564.6 | 1435.9 | 974.8 | 349.64 | 590.6 | 1452.6 | 1.57 | 0.43 | 1.09 | 2.09 | 0.23 | 0.24 | 0.03 | 0.76 |
| 55 | SING | 1.00 | 200 | 0 | 0 | 923.6 | 349.24 | 537.9 | 1399.8 | 964.8 | 341.[illegible] | 589.7 | 1434.4 | [illegible] | [illegible] | [illegible] | 2.12 | 0.23 | 0.24 | 0.03 | 0.76 |
| 56 | MULT | 1.00 | 200 | 0 | 0 | 1009.0 | 383.80 | 590.6 | 1519.5 | 1009.0 | 383.[illegible] | [illegible] | 1519.5 | 1.85 | 0.65 | 1.14 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 57 | MULT | 1.00 | 500 | 0 | 0 | 967.8 | 674.63 | 97.7 | 2179.2 | 967.8 | 674.[illegible] | [illegible] | 2179.2 | [illegible] | [illegible] | [illegible] | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 58 | SING | 1.00 | 500 | 0 | 0 | 967.8 | 674.63 | 97.7 | 2179.2 | 1001.7 | 685.31 | 129.7 | 2235.8 | 2.51 | 1.20 | 1.01 | 5.00 | 0.75 | 0.87 | 0.00 | 4.57 |



Figure 4-21 #2 Leg 6 (4 of 6)

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 59 | SING | 1.00 | 500 | 0 | 0 | 1001.7 | 685.31 | 129.7 | 2235.8 | 1005.0 | 683.12 | 129.7 | 2235.8 | 2.59 | 1.32 | 1.01 | 5.00 | 0.82 | 1.00 | 0.00 | 4.57 |
| 60 | SING | 1.00 | 500 | 0 | 0 | 1005.0 | 683.12 | 129.7 | 2235.8 | 1017.3 | 703.01 | 129.7 | 2300.0 | 2.60 | 1.31 | 1.01 | 5.00 | 0.83 | 1.00 | 0.00 | 4.57 |
| 61 | SING | 1.00 | 500 | 0 | 0 | 967.8 | 674.63 | 97.7 | 2179.2 | 1092.4 | 719.47 | 186.0 | 2359.0 | 2.59 | 1.00 | 1.02 | 4.65 | 0.71 | 0.61 | 0.00 | 3.28 |
| 62 | SING | 1.00 | 500 | 0 | 0 | 1017.3 | 703.01 | 129.7 | 2300.0 | 1031.7 | 693.24 | 160.7 | 2300.0 | 2.62 | 1.35 | 1.01 | 5.00 | 0.91 | 1.16 | 0.00 | 4.57 |
| 63 | SING | 1.00 | 500 | 0 | 0 | 1031.7 | 693.24 | 160.7 | 2300.0 | 1037.5 | 686.14 | 190.9 | 2300.0 | 2.63 | 1.36 | 1.01 | 5.00 | 0.91 | 1.14 | 0.00 | 4.57 |
| 64 | MULT | 1.00 | 500 | 0 | 0 | 967.8 | 674.63 | 97.7 | 2179.2 | 1062.2 | 705.42 | 185.3 | 2361.2 | 2.44 | 1.16 | 1.01 | 5.00 | 0.71 | 0.84 | 0.00 | 4.31 |
| 65 | SING | 1.00 | 500 | 0 | 0 | 967.8 | 674.63 | 97.7 | 2179.2 | 1071.6 | 708.68 | 185.2 | 2361.5 | 2.55 | 1.24 | 1.01 | 5.00 | 0.76 | 0.86 | 0.00 | 4.57 |
| 66 | MULT | 1.00 | 500 | 0 | 0 | 1093.9 | 718.80 | 190.9 | 2361.5 | 1093.9 | 718.80 | 190.9 | 2361.5 | 2.62 | 1.36 | 1.02 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 77 | MULT | 1.00 | 100 | 0 | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 78 | MULT | 1.00 | 102 | 2. | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 79 | MULT | 1.00 | 100 | 0 | 0. | 0.0 | 0.00 | 0.0 | 0.0 | 30.9 | 1.03 | 28.2 | 32.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 80 | MULT | 1.00 | 107 | 7 | 0 | 31.7 | 3.56 | 28.2 | 53.7 | 43.8 | 6.72 | 30.5 | 68.3 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 81 | MULT | 1.00 | 100 | 0 | 0 | 43.8 | 6.81 | 30.5 | 68.3 | 53.9 | 8.16 | 33.1 | 81.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 82 | MULT | 1.00 | 100 | 0 | 0 | 53.9 | 8.16 | 33.1 | 81.6 | 111.3 | 7.40 | 92.9 | 135.4 | 1.03 | 0.01 | 1.01 | 1.05 | 0.01 | 0.00 | 0.00 | 0.01 |
| 83 | MULT | 1.00 | 100 | 0 | 0 | 53.9 | 8.16 | 33.1 | 81.6 | 63.7 | 8.60 | 43.6 | 92.9 | 1.02 | 0.00 | 1.01 | 1.04 | 0.01 | 0.00 | 0.00 | 0.01 |
| 84 | MULT | 1.00 | 109 | 9 | 0 | 64.2 | 8.70 | 43.6 | 92.9 | 75.0 | 10.24 | 53.4 | 100.3 | 1.02 | 0.00 | 1.01 | 1.04 | 0.01 | 0.00 | 0.00 | 0.01 |
| 85 | MULT | 1.00 | 100 | 0 | 0 | 75.4 | 10.33 | 53.4 | 100.3 | 84.6 | 10.83 | 58.2 | 109.1 | 1.02 | 0.00 | 1.01 | 1.04 | 0.01 | 0.00 | 0.00 | 0.01 |
| 86 | MULT | 1.00 | 100 | 0 | 0 | 84.6 | 10.83 | 58.2 | 109.1 | 103.3 | 16.30 | 71.4 | 145.2 | 1.02 | 0.00 | 1.01 | 1.04 | 0.01 | 0.00 | 0.00 | 0.01 |
| 88 | MULT | 1.00 | 100 | 0 | 0. | 113.9 | 10.01 | 92.9 | 145.2 | 113.9 | 10.01 | 92.9 | 145.2 | 1.03 | 0.01 | 1.01 | 1.06 | 0.00 | 0.00 | 0.00 | 0.00 |
| 89 | MULT | 1.00 | 200 | 0 | 0 | 2056.7 | 377.70 | 1626.0 | 2840.4 | 2056.7 | 377.70 | 1626.0 | 2840.4 | 3.26 | 1.01 | 2.50 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 90 | MULT | 1.00 | 200 | 0 | 0 | 2056.7 | 377.70 | 1626.0 | 2840.4 | 2073.3 | 361.55 | 1659.2 | 2840.4 | 3.28 | 1.34 | 2.00 | 5.00 | 1.27 | 1.33 | 0.29 | 4.57 |
| 91 | MULT | 1.00 | 200 | 0 | 0 | 2073.3 | 361.55 | 1659.2 | 2840.4 | 2083.0 | 366.80 | 1664.0 | 2858.9 | 3.17 | 1.28 | 2.00 | 5.00 | 1.20 | 1.32 | 0.29 | 4.57 |
| 92 | MULT | 1.00 | 200. | 0 | 0 | 2083.0 | 366.80 | 1664.0 | 2358.9 | 2083.0 | 366.80 | 1664.0 | 2858.9 | 3.24 | 1.33 | 2.00 | 5.00 | 1.26 | 1.33 | 0.29 | 4.57 |
| 93 | MULT | 1.00 | 200 | 0 | 0 | 2083.0 | 366.80 | 1664.0 | 2858.9 | 2083.0 | 366.80 | 1664.0 | 2858.9 | 3.24 | 1.33 | 2.00 | 5.00 | 1.26 | 1.33 | 0.29 | 4.57 |
| 94 | MULT | 1.00 | 200 | 0 | 0. | 2083.0 | 366.80 | 1664.0 | 2858.9 | 2083.0 | 366.80 | 1664.0 | 2858.9 | 3.23 | 1.03 | 2.50 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 95 | MULT | 1.00 | 400 | 0 | 0 | 811.2 | 599.50 | 215.8 | 1869.9 | 811.2 | 599.50 | 215.8 | 1869.9 | 2.02 | 0.95 | 1.05 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 96 | MULT | 1.00 | 400. | 0. | 0. | 811.2 | 599.50 | 215.8 | 1869.9 | 852.5 | 609.89 | 246.7 | 1925.9 | 2.20 | 1.13 | 1.03 | 4.80 | 0.57 | 0.61 | 0.01 | 3.42 |
| 97 | MULT | 1.00 | 400 | 0 | 0 | 852.5 | 609.89 | 246.7 | 1925.9 | 894.8 | 621.88 | 275.3 | 1987.9 | 2.34 | 1.29 | 1.03 | 5.00 | 0.66 | 0.74 | 0.01 | 4.57 |
| 98 | SING | 1.00 | 400 | 0 | 0 | 852.5 | 609.89 | 246.7 | 1925.9 | 936.2 | 641.95 | 298.1 | 2046.3 | 2.67 | 1.59 | 1.08 | 5.00 | 0.80 | 0.91 | 0.01 | 4.57 |
| 99 | MULT | 1.00 | 400 | 0 | 0 | 852.5 | 609.89 | 246.7 | 1925.9 | 917.3 | 635.26 | 302.3 | 2049.6 | 1.92 | 0.99 | 1.03 | 3.50 | 0.38 | 0.41 | 0.01 | 1.32 |
| 100 | MULT | 1.00 | 400 | 0 | 0 | 894.8 | 621.88 | 275.3 | 1987.9 | 894.8 | 621.88 | 275.3 | 1987.9 | 2.54 | 1.51 | 1.05 | 5.00 | 0.92 | 1.15 | 0.01 | 4.57 |
| 101 | MULT | 1.00 | 400 | 0 | 0 | 894.8 | 621.88 | 275.3 | 1987.9 | 894.8 | 621.88 | 275.3 | 1987.9 | 2.54 | 1.51 | 1.05 | 5.00 | 0.92 | 1.15 | 0.01 | 4.57 |
| 102 | MULT | 1.00 | 400 | 0. | 0 | 939.2 | 640.12 | 302.3 | 2049.6 | 939.2 | 640.12 | 302.3 | 2049.6 | 2.49 | 1.57 | 1.08 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 117 | MULT | 1.00 | 100 | 0 | 0 | 1167.1 | 667.61 | 448.0 | 2361.5 | 1167.1 | 667.61 | 448.0 | 2361.5 | 2.99 | 1.66 | 1.12 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 118 | MULT | 1.00 | 527 | 127. | 0. | 1405.6 | 751.32 | 448.0 | 2448.8 | 1423.3 | 763.44 | 462.6 | 2483.1 | 3.02 | 1.69 | 1.08 | 5.00 | 1.36 | 1.31 | 0.02 | 4.57 |
| 119 | MULT | 1.00 | 400. | 0 | 0 | 1190.4 | 693.48 | 462.6 | 2483.1 | 1220.9 | 709.04 | 487.0 | 2546.1 | 2.47 | 1.50 | 1.08 | 5.00 | 1.29 | 1.73 | 0.02 | 4.57 |
| 120 | MULT | 1.00 | 507 | 107 | 0 | 1462.9 | 785.36 | 487.0 | 2546.1 | 1462.9 | 785.38 | 487.0 | 2546.1 | 3.00 | 1.69 | 1.08 | 5.00 | 1.38 | 1.34 | 0.02 | 4.57 |
| 121 | MULT | 1.00 | 400 | 0 | 0 | 1220.9 | 709.04 | 487.0 | 2546.1 | 1220.9 | 709.04 | 487.0 | 2546.1 | 2.46 | 1.51 | 1.08 | 5.00 | 1.37 | 1.87 | 0.02 | 4.57 |
| 122 | MULT | 1.00 | 400. | 0 | 0 | 1220.9 | 709.04 | 487.0 | 2546.1 | 1220.9 | 709.04 | 487.0 | 2546.1 | 2.46 | 1.51 | 1.08 | 5.00 | 0.96 | 1.19 | 0.02 | 4.57 |

Figure 4-21 #2 Leg 6 (5 of 6)

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD. | BUSY TIME MIN | BUSY TIME MAX | IDLE TIME MEAN | IDLE TIME STD. | IDLE TIME MIN. | IDLE TIME MAX. | TOTAL TIME USED MEAN | TOTAL TIME USED STD | TOTAL TIME USED MIN. | TOTAL TIME USED MAX. | STRESS MEAN | STRESS STD | STRESS MIN. | STRESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2500.00 | 1823.5 | 128.5 | 1664.2 | 2261.5 | 633.9 | 22.6 | 591.4 | 698.7 | 2457.3 | 137.4 | 2312.6 | 2913.8 | 2.08 | 0.19 | 1.76 | 2.67 |
| 2 | 2500.00 | 1767.8 | 145.7 | 1561.1 | 2230.0 | 689.5 | 24.9 | 617.0 | 768.0 | 2457.3 | 137.4 | 2312.6 | 2913.8 | 1.96 | 0.21 | 1.64 | 2.58 |
| 3 | 2500.00 | 1767.8 | 145.7 | 1561.1 | 2230.0 | 689.5 | 24.9 | 617.0 | 768.0 | 2457.3 | 137.4 | 2312.6 | 2913.8 | 1.96 | 0.21 | 1.64 | 2.50 |
| 4 | 2500.00 | 1946.2 | 14.2 | 1749.1 | 2419.2 | 511.2 | 27.1 | 469.5 | 578.7 | 2457.3 | 137.4 | 2312.6 | 2913.8 | 2.08 | 0.20 | 1.75 | 2.66 |
| 5 | 2500.00 | 1664.3 | 9.1 | 1640.2 | 1692.8 | 773.1 | 124.8 | 638.1 | 1204.1 | 2437.4 | 125.2 | 2298.2 | 2858.9 | 2.42 | 0.07 | 2.32 | 2.61 |
| 6 | 2500.00 | 316.9 | 4.4 | 306.4 | 344.3 | 2120.5 | 125.4 | 1980.5 | 2549.9 | 2437.4 | 125.2 | 2298.2 | 2858.9 | 1.80 | 0.07 | 1.71 | 2.00 |
| 7 | 2500.00 | 316.9 | 4.4 | 306.4 | 344.3 | 2120.5 | 125.4 | 1980.5 | 2549.9 | 2437.4 | 125.2 | 2298.2 | 2858.9 | 1.80 | 0.07 | 1.71 | 2.00 |

83 SUCCESSFUL MISSIONS

17 UNSUCCESSFUL MISSIONS

Figure 4-21 #2 Leg 6 (6 of 6)

4.1.2.2 Test and Demonstration Results (Cont'd)

Time Task Completed (in seconds)

| | Min. | Max. | Std. |
|---|---|---|---|
| #1 | 2320.6 | 3064.6 | 153.74 |
| #2 | 2312.6 | 2913.8 | 137.44 |

The average time to complete leg 6 of the RTP was 38.7 seconds greater for #1 than for #2. This time saving in #2 is due mainly to the fact that the keyboard and the instructor position at the console are adjacent to the two CRTs. There is no remote display. Thus, inserting changes to a page via keyboard, under a time limit, is done more efficiently when the keyboard and the CRT are adjacent.

A comparison of the average stresses felt by the operators on #1 and #2 is shown in Table 4-7.

Table 4-7 Comparative Stress Levels (Leg 6)

| #1 Mean Stress | Operator Number | #2 Mean Stress | ΔStress |
|---|---|---|---|
| 2.19 | 1 | 2.08 | 0.11 |
| 2.03 | 2 | 1.96 | 0.12 |
| 2.08 | 3 | 1.96 | 0.12 |
| 2.19 | 4 | 2.08 | 0.11 |
| 2.43 | 5 | 2.42 | 0.01 |
| 1.79 | 6 | 1.80 | 0.01 |
| 1.79 | 7 | 1.80 | 0.01 |

Once again, there is a great decrease in the stress associated with operators 1 to 4. The logic for this decrease in stress is the same as has previously been discussed.

In RTP leg 7, the parameter sets differed from #1 to #2 in only three tasks. Those tasks are:

| #1 Parameter Set | Task | #2 Parameter Set |
|---|---|---|
| G | 1 | H |
| A | 43 | B |
| A | 50 | B |

4.1.2.2 Test and Demonstration Results (Cont'd)

The operator stress threshold, accuracy factor and speed factor remained the same as in the other legs of the RTP. The time assigned to leg 7 was 600 seconds. Only these tasks were designated dormant:

| | |
|---|---|
| 42 | 70 |
| 48 | 76 |
| 49 | 89 |
| 52 | 92 |
| 56 | 94 |
| 67 | |

The results from running data of #1 and #2 are shown in Figure 4-22.

The Mission Summary Reports show 100 successful completions for both #1 and #2. The Task Summary Report shows the times of completion of the leg to be:

Time Task Completed (in seconds)

| | Mean | Min. | Max. | Std. |
|---|---|---|---|---|
| #1 | 524.0 | 500.0 | 544.0 | 9.36 |
| #2 | 534.6 | 505.5 | 576.0 | 15.57 |

The difference between #1 and #2 is that the operators of #1 average 10 seconds less to complete the mission than those on #2. The stress levels for each operator are shown in Table 4-3.

Table 4-8 Comparative Stress Levels (Leg 7)

| #1 Mean Stress | Operator Number | #2 Mean Stress | ΔStress |
|---|---|---|---|
| 1.06 | 1 | 1.05 | 0.01 |
| 1.02 | 2 | 1.01 | 0.01 |
| 1.02 | 3 | 1.01 | 0.01 |
| 1.02 | 4 | 1.01 | 0.01 |
| 0.99 | 5 | 0.99 | 0.00 |
| 0.97 | 6 | 0.97 | 0.00 |
| 0.97 | 7 | 0.97 | 0.00 |

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK NO | TASK TYPE | TASK ESS. | ---COUNTERS--- REL. | FAIL | SKIP | -----TIME TASK REALIZED---- MEAN | STD. | MIN. | MAX. | ----TIME TASK COMPLETED---- MEAN | STD. | MIN | MAX. | ----TASK STRESS---- MEAN | STD | MIN | MAX. | -TASK COHESIVENESS- MEAN | STD. | MIN. | MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MULT | 1.00 | 121. | 21 | 0. | 2.8 | 6.83 | 0.0 | 35.8 | 14.2 | 7.28 | 2.0 | 44.5 | 1.25 | 0.04 | 1.24 | 1.45 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | MULT | 1.00 | 100 | 0 | 0. | 524.0 | 9.36 | 500.0 | 544.0 | 524.0 | 9.36 | 500.0 | 544.0 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 42 | MULT | 1.00 | 100 | 0 | 0. | 13.8 | 7.20 | 2.0 | 44.5 | 13.8 | 7.20 | 2.0 | 44.5 | 1.21 | 0.04 | 1.15 | 1.40 | 0.00 | 0.00 | 0.00 | 0.00 |
| 43 | SING | 1.00 | 100. | 0. | 0. | 13.8 | 7.20 | 2.0 | 44.5 | 36.0 | 5.92 | 27.1 | 62.2 | 1.25 | 0.07 | 1.16 | 1.53 | 0.05 | 0.02 | 0.03 | 0.14 |
| 44 | SING | 1.00 | 100. | 0. | 0. | 13.8 | 7.20 | 2.0 | 44.5 | 149.0 | 2.28 | 144.1 | 154.4 | 1.20 | 0.06 | 1.11 | 1.49 | 0.05 | 0.02 | 0.03 | 0.14 |
| 45 | MULT | 1.00 | 100 | 0 | 0. | 13.8 | 7.20 | 2.0 | 44.5 | 149.0 | 2.29 | 144.1 | 154.5 | 1.20 | 0.06 | 1.11 | 1.49 | 0.05 | 0.02 | 0.03 | 0.14 |
| 46 | SING | 1.00 | 100. | 0. | 0. | 36.0 | 5.92 | 27.1 | 62.2 | 166.6 | 2.44 | 160.9 | 172.7 | 1.23 | 0.06 | 1.14 | 1.31 | 0.05 | 0.02 | 0.03 | 0.13 |
| 47 | SING | 1.06 | 100. | 0. | 0. | 13.8 | 7.20 | 2.0 | 44.5 | 149.0 | 2.30 | 144.1 | 154.6 | 1.20 | 0.06 | 1.11 | 1.49 | 0.05 | 0.02 | 0.03 | 0.14 |
| 48 | MULT | 1.00 | 100. | 0 | 0 | 166.6 | 2.44 | 160.9 | 172.7 | 166.6 | 2.44 | 160.9 | 172.7 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 49 | MULT | 1.00 | 100 | 0. | 0. | 166.6 | 2.44 | 160.9 | 172.7 | 166.6 | 2.44 | 160.9 | 172.7 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 50 | SING | 1.00 | 100 | 0. | 0. | 156.6 | 2.44 | 160.9 | 172.7 | 197.7 | 2.73 | 191.2 | 203.8 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 51 | SING | 1.00 | 100 | 0. | 0. | 166.6 | 2.44 | 160.9 | 172.7 | 226.6 | 2.47 | 220.8 | 232.7 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 52 | SING | 1.00 | 100. | 0. | 0. | 197.7 | 2.73 | 191.2 | 203.8 | 197.7 | 2.73 | 191.2 | 203.8 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 53 | MULT | 1.00 | 100 | 0. | 0. | 166.6 | 2.44 | 160.9 | 172.7 | 226.6 | 2.44 | 220.9 | 232.9 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 54 | SING | 1.00 | 100. | 0 | 0. | 197.7 | 2.73 | 191.2 | 203.8 | 228.8 | 2.86 | 221.8 | 234.4 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 55 | SING | 1.00 | 100 | 0 | 0. | 166.6 | 2.44 | 160.9 | 172.7 | 226.6 | 2.50 | 220.8 | 232.5 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 56 | MULT | 1.00 | 100. | 0 | 0. | 228.8 | 2.85 | 221.8 | 234.4 | 228.8 | 2.85 | 221.8 | 234.4 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 67 | MULT | 1.00 | 100 | 0 | 0 | 228.8 | 2.85 | 221.8 | 234.4 | 228.8 | 2.85 | 221.8 | 234.4 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 68 | MULT | 1.00 | 100 | 0 | 0. | 228.8 | 2.85 | 221.8 | 234.4 | 241.5 | 7.03 | 224.4 | 255.4 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 69 | SING | 1.00 | 100 | 0 | 0 | 241.5 | 7.03 | 224.4 | 255.4 | 272.8 | 7.22 | 255.0 | 288.2 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 70 | SING | 1.00 | 100. | 0. | 0. | 272.8 | 7.22 | 255.0 | 288.2 | 272.8 | 7.22 | 255.0 | 288.2 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 71 | SING | 1.00 | 100. | 0 | 0. | 272.8 | 7.22 | 255.0 | 288.2 | 303.7 | 7.29 | 284.3 | 318.0 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 72 | SING | 1.00 | 100 | 0 | 0. | 303.7 | 7.29 | 284.3 | 318.0 | 335.0 | 7.36 | 314.6 | 349.7 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 73 | MULT | 1.00 | 100 | 0 | 0 | 228.8 | 2.85 | 221.8 | 234.4 | 318.9 | 2.86 | 311.8 | 324.8 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 74 | MULT | 1.00 | 100 | 0 | 0 | 335.0 | 7.36 | 314.6 | 349.7 | 425.0 | 7.33 | 404.7 | 439.7 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 75 | SING | 1.00 | 100 | 0 | 0 | 228.8 | 2.85 | 221.8 | 234.4 | 318.8 | 2.89 | 312.2 | 324.8 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 76 | MULT | 1.00 | 100 | 0. | 0. | 425.0 | 7.33 | 404.7 | 439.7 | 425.0 | 7.33 | 404.7 | 439.7 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 89 | MULT | 1.00 | 100 | 0. | 0. | 425.0 | 7.33 | 404.7 | 439.7 | 425.0 | 7.33 | 404.7 | 439.7 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 90 | MULT | 1.00 | 100. | 0. | 0. | 425.0 | 7.33 | 404.7 | 439.7 | 449.0 | 7.35 | 429.9 | 464.0 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 91 | MULT | 1.00 | 100 | 0 | 0. | 449.0 | 7.35 | 429.9 | 464.0 | 509.0 | 7.33 | 490.2 | 523.9 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 92 | MULT | 1.00 | 100 | 0. | 0. | 509.0 | 7.33 | 490.2 | 523.9 | 509.0 | 7.33 | 490.2 | 523.9 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 93 | MULT | 1.00 | 100 | 0. | 0. | 509.0 | 7.33 | 490.2 | 523.9 | 524.0 | 7.36 | 500.0 | 544.0 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 94 | MULT | 1.00 | 100 | 0 | 0 | 524.0 | 9.36 | 500.0 | 544.0 | 524.0 | 9.36 | 500.0 | 544.0 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Figure 4-22 #1 Leg 7 (1 of 4)

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD | BUSY TIME MIN | BUSY TIME MAX | IDLE TIME MEAN | IDLE TIME STD. | IDLE TIME MIN. | IDLE TIME MAX. | TOTAL TIME USED MEAN | TOTAL TIME USED STD. | TOTAL TIME USED MIN. | TOTAL TIME USED MAX. | STRESS MEAN | STRESS STD. | STRESS MIN. | STRESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 600.00 | 523.9 | 9.4 | 499.7 | 544.0 | 0.0 | 0.2 | 0.0 | 1.3 | 524.0 | 9.4 | 500.0 | 544.0 | 1.06 | 0.01 | 1.05 | 1.12 |
| 2 | 600.00 | 410.7 | 8.8 | 390.3 | 428.1 | 113.3 | 2.3 | 105.6 | 118.9 | 524.0 | 9.4 | 500.0 | 544.0 | 1.02 | 0.01 | 1.00 | 1.07 |
| 3 | 600.00 | 410.7 | 8.8 | 390.3 | 428.1 | 113.3 | 2.3 | 105.6 | 118.9 | 524.0 | 9.4 | 500.0 | 544.0 | 1.02 | 0.01 | 1.00 | 1.07 |
| 4 | 600.00 | 398.0 | 5.5 | 384.3 | 414.9 | 126.0 | 7.1 | 106.7 | 141.4 | 524.0 | 9.4 | 500.0 | 544.0 | 1.02 | 0.01 | 1.00 | 1.07 |
| 5 | 600.00 | 285.2 | 9.3 | 252.0 | 302.1 | 238.8 | 12.6 | 211.4 | 274.1 | 524.0 | 9.4 | 500.0 | 544.0 | 0.99 | 0.01 | 0.97 | 1.06 |
| 6 | 600.00 | 90.0 | 0.2 | 89.3 | 90.6 | 433.9 | 9.4 | 409.8 | 454.0 | 524.0 | 9.4 | 500.0 | 544.0 | 0.97 | 0.01 | 0.91 | 1.00 |
| 7 | 600.00 | 90.0 | 0.2 | 89.3 | 90.6 | 433.9 | 9.4 | 409.8 | 454.0 | 524.0 | 9.4 | 500.0 | 544.0 | 0.97 | 0.01 | 0.91 | 1.00 |

100 SUCCESSFUL MISSIONS

0 UNSUCCESSFUL MISSIONS

Figure 4-22 #1 Leg 7 (2 of 4)

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK NO | TASK TYPE | TASK ESS. | COUNTERS REL | COUNTERS FAIL | COUNTERS SKIP | TIME TASK REALIZED MEAN | TIME TASK REALIZED STD | TIME TASK REALIZED MIN. | TIME TASK REALIZED MAX | TIME TASK COMPLETED MEAN | TIME TASK COMPLETED STD | TIME TASK COMPLETED MIN. | TIME TASK COMPLETED MAX. | TASK STRESS MEAN | TASK STRESS STD. | TASK STRESS MIN. | TASK STRESS MAX. | TASK COHESIVENESS MEAN | TASK COHESIVENESS STD. | TASK COHESIVENESS MIN. | TASK COHESIVENESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MULT | 1.00 | 102 | 2 | 0 | 0.3 | 1.85 | 0.0 | 14.2 | 10.5 | 5.83 | 0.0 | 33.2 | 1.21 | 0.01 | 1.20 | 1.20 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | MULT | 1.00 | 100 | 0 | 0 | 534.6 | 15.57 | 505.5 | 576.4 | 534.6 | 15.57 | 505.5 | 576.4 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 42 | MULT | 1.00 | 100 | 0 | 0 | 10.5 | 5.88 | 0.0 | 33.2 | 10.5 | 5.88 | 0.0 | 33.2 | 1.19 | 0.03 | 1.14 | 1.32 | 0.00 | 0.00 | 0.00 | 0.00 |
| 43 | SING | 1.00 | 100 | 0 | 0 | 10.5 | 5.88 | 0.0 | 33.2 | 33.3 | 4.54 | 24.6 | 51.1 | 1.22 | 0.05 | 1.14 | 1.43 | 0.05 | 0.01 | 0.03 | 0.10 |
| 44 | SING | 1.00 | 100 | 0 | 0 | 10.5 | 5.88 | 0.0 | 33.2 | 150.8 | 2.78 | 144.7 | 156.9 | 1.17 | 0.05 | 1.09 | 1.37 | 0.05 | 0.01 | 0.03 | 0.10 |
| 45 | MULT | 1.00 | 100 | 0 | 0 | 10.5 | 5.88 | 0.0 | 33.2 | 150.7 | 2.79 | 144.5 | 156.6 | 1.17 | 0.05 | 1.09 | 1.37 | 0.05 | 0.01 | 0.02 | 0.10 |
| 46 | SING | 1.00 | 100 | 0 | 0 | 33.3 | 4.54 | 24.6 | 51.1 | 168.3 | 2.85 | 161.0 | 174.5 | 1.20 | 0.04 | 1.12 | 1.39 | 0.04 | 0.01 | 0.02 | 0.09 |
| 47 | SING | 1.00 | 100 | 0 | 0 | 10.5 | 5.88 | 0.0 | 33.2 | 150.8 | 2.82 | 144.7 | 157.0 | 1.17 | 0.05 | 1.09 | 1.37 | 0.05 | 0.01 | 0.03 | 0.10 |
| 48 | MULT | 1.00 | 100 | 0 | 0 | 168.3 | 2.85 | 161.0 | 174.5 | 168.3 | 2.85 | 161.0 | 174.5 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 49 | MULT | 1.00 | 100 | 0 | 0 | 168.3 | 2.85 | 161.0 | 174.5 | 168.3 | 2.35 | 161.0 | 174.5 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 50 | SING | 1.00 | 100 | 0 | 0 | 168.3 | 2.85 | 161.0 | 174.5 | 199.3 | 2.94 | 190.5 | 206.0 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 51 | SING | 1.00 | 100 | 0 | 0 | 168.3 | 2.85 | 161.0 | 174.5 | 228.2 | 2.85 | 221.2 | 234.4 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 52 | SING | 1.00 | 100 | 0 | 0 | 199.3 | 2.94 | 190.5 | 206.0 | 199.3 | 2.94 | 190.5 | 206.0 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 53 | MULT | 1.00 | 100 | 0 | 0 | 168.3 | 2.85 | 161.0 | 174.5 | 228.3 | 2.82 | 221.2 | 234.5 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 54 | SING | 1.00 | 100 | 0 | 0 | 199.3 | 2.94 | 190.5 | 206.0 | 230.3 | 3.11 | 221.0 | 236.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 55 | SING | 1.00 | 100 | 0 | 0 | 168.3 | 2.85 | 161.0 | 174.5 | 228.2 | 2.85 | 221.2 | 234.4 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 56 | MULT | 1.00 | 100 | 0 | 0 | 230.4 | 3.00 | 221.2 | 236.6 | 230.4 | 3.00 | 221.2 | 236.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 67 | MULT | 1.00 | 100 | 0 | 0 | 230.4 | 3.00 | 221.2 | 236.6 | 230.4 | 3.00 | 221.2 | 236.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 68 | MULT | 1.00 | 100 | 0 | 0 | 230.4 | 3.00 | 221.2 | 236.6 | 230.9 | 13.20 | 227.0 | 281.9 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 69 | SING | 1.00 | 100 | 0 | 0 | 250.9 | 13.20 | 227.0 | 281.9 | 281.8 | 13.23 | 258.2 | 312.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 70 | SING | 1.00 | 100 | 0 | 0 | 281.8 | 13.23 | 258.2 | 312.6 | 281.8 | 13.23 | 258.2 | 312.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 71 | SING | 1.00 | 100 | 0 | 0 | 281.8 | 13.23 | 258.2 | 312.6 | 312.8 | 13.18 | 289.2 | 343.4 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 72 | SING | 1.00 | 100 | 0 | 0 | 312.8 | 13.18 | 289.2 | 343.4 | 344.1 | 13.14 | 321.0 | 375.0 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 73 | MULT | 1.00 | 100 | 0 | 0 | 230.4 | 3.00 | 221.2 | 236.6 | 320.4 | 2.98 | 311.6 | 326.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 74 | MULT | 1.00 | 100 | 0 | 0 | 344.1 | 13.14 | 321.0 | 375.0 | 434.0 | 13.13 | 411.3 | 465.2 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 75 | SING | 1.00 | 100 | 0 | 0 | 230.4 | 3.00 | 221.2 | 236.6 | 320.4 | 2.98 | 311.7 | 326.9 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 76 | MULT | 1.00 | 100 | 0 | 0 | 434.0 | 13.13 | 411.3 | 465.2 | 434.0 | 13.13 | 411.3 | 465.2 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 89 | MULT | 1.00 | 100 | 0 | 0 | 434.0 | 13.13 | 411.3 | 465.2 | 434.0 | 13.13 | 411.3 | 465.2 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 90 | MULT | 1.00 | 100 | 0 | 0 | 434.0 | 13.13 | 411.3 | 465.2 | 458.0 | 13.14 | 435.1 | 489.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 91 | MULT | 1.00 | 100 | 0 | 0 | 458.0 | 13.14 | 435.1 | 489.6 | 518.0 | 13.20 | 495.0 | 549.3 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 92 | MULT | 1.00 | 100 | 0 | 0 | 518.0 | 13.20 | 495.0 | 549.3 | 518.0 | 13.20 | 495.0 | 549.3 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 93 | MULT | 1.00 | 100 | 0 | 0 | 518.0 | 13.20 | 495.0 | 549.3 | 534.6 | 15.57 | 505.5 | 576.4 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 94 | MULT | 1.00 | 100 | 0 | 0 | 534.6 | 15.57 | 505.5 | 576.4 | 534.6 | 15.57 | 505.5 | 576.4 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Figure 4-22 #2 Leg 7 (3 of 4)

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD | BUSY TIME MIN. | BUSY TIME MAX | IDLE TIME MEAN | IDLE TIME STD | IDLE TIME MIN. | IDLE TIME MAX | TOTAL TIME USED MEAN | TOTAL TIME USED STD | TOTAL TIME USED MIN | TOTAL TIME USED MAX. | STRESS MEAN | STRESS STD. | STRESS MIN. | STRESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 600.00 | 534.5 | 15.6 | 505.5 | 576.4 | 0.1 | 0.3 | 0.0 | 2.0 | 534.6 | 15.6 | 505.5 | 576.4 | 1.05 | 0.01 | 1.04 | 1.08 |
| 2 | 600.00 | 421.8 | 15.7 | 390.9 | 463.3 | 112.9 | 2.2 | 107.9 | 118.5 | 534.6 | 15.6 | 505.5 | 576.4 | 1.01 | 0.01 | 1.00 | 1.05 |
| 3 | 600.00 | 421.8 | 15.7 | 390.9 | 463.3 | 112.8 | 2.2 | 107.9 | 118.5 | 534.6 | 15.6 | 505.5 | 576.4 | 1.01 | 0.01 | 1.00 | 1.05 |
| 4 | 600.00 | 401.4 | 8.4 | 302.3 | 421.6 | 133.2 | 13.0 | 111.7 | 164.7 | 534.6 | 15.6 | 505.5 | 576.4 | 1.01 | 0.01 | 1.00 | 1.05 |
| 5 | 600.00 | 290.3 | 8.6 | 262.1 | 306.7 | 244.3 | 16.9 | 206.2 | 280.7 | 534.6 | 15.6 | 505.5 | 576.4 | 0.99 | 0.00 | 0.96 | 1.00 |
| 6 | 600.00 | 90.0 | 0.2 | 89.6 | 90.7 | 444.6 | 15.5 | 415.7 | 486.0 | 534.6 | 15.6 | 505.5 | 576.4 | 0.98 | 0.01 | 0.94 | 1.00 |
| 7 | 600.00 | 90.0 | 0.2 | 89.6 | 90.7 | 444.6 | 15.5 | 415.7 | 486.0 | 534.6 | 15.6 | 505.5 | 576.4 | 0.98 | 0.01 | 0.94 | 1.00 |

100 SUCCESSFUL MISSIONS

0 UNSUCCESSFUL MISSIONS

Figure 4-22 #2 Leg 7 (4 of 4)

Even though the operators of #1 took 10 seconds less to complete RTP 7, the operators of #2 had lower stress levels. RTP 7 is performed when the aircraft is under TOTAL FREEZE, i.e., all parameters are frozen. Neither the instructor pilot nor the trainee feel any pressure. This was the reason for the large amount of time that was assigned to RTP 7. The leg of the RTP is also much too short to show the cumulative effects of the different features on #1 and #2.

The results of leg 3 to 6 of the RTP show a sum of 32 more successful missions using the #2 configuration.

The times taken to complete a leg of the RTP were consistently lower for the #2 configuration than for #1.

Operators on #2 were subject to lower stress levels than the operators on #1.

Configuration #2 is clearly the better design for an instructor station. This agrees with the opinion of the user who asked to have the original #1 layout modified to the #2 configuration at their cost.

4.1.3 Candidate Interface Methods. Three IOS devices were used in the demonstration tests:

(a) Keyboard/CRT action

(b) Dedicated push button/CRT action

(c) Light pen/CRT action.

Each IOS device was used in the implementation of an ITD item. The ITD items used were ACTIVATE DISCRETE MALFUNCTION and CALL UP MAPPING DISPLAY. The discrete malfunction item entailed the calling up of the malfunctions page on a CRT and activating the desired line. This task was performed by each of the candidate methods. The mapping display item consisted of setting a scale for the map and then centering the map. Each candidate method was used to perform this task.

The fact that the keyboard and the direct action push button are two of the most often used IOS devices provided the rationale behind their selection as candidate interface techniques. Both may be employed in simple and complex input tasks. The keyboard has great flexibility and the push button represents quick system response and functional complexity limited only by the software capability available at the IOS.

The light pen is a device suitable for both simple and complex tasks in connection with a CRT display. Its greatest advantage is in the capability of making precise and limited changes in a complex pattern, such as mapping or tactical display, where the task time and the risk of input error must be minimized.

4.1.3.1 Basic Approach. The existing analytical networks, i.e., TAMs and RTP, represent typical activities and conventional IOS devices and functions related to a representative task sequence.

The existing TAMs describing the use of a keyboard, push button, and light pen were fitted with the appropriate parameter sets (see paragraph 4.1.3.2) for the jet trainer console. The tasks, within the TAMs which call for the instructor to verify that the new data input is correct, were always activated. The TAMs, which constitute the static phase of an investigation, established the times necessary to perform a task using a particular interface method, thus establishing the basis, i.e., time requirements, operator stress levels, by which the suitability of the device could be determined.

The data generated by the TAMs, i.e., mean, maximum, minimum times of completion of the TAM, were incorporated into the model of the RTP to form the dynamic phase of the evaluation. The purpose of the dynamic phase of the evaluation was to determine the suitability of the interface device as an integral part of an entire IOS console. In order to perform this evaluation, each leg of the RTP was examined to determine the number of times discrete malfunctions had to be called up, and then the number of times mapping displays were used. Leg 6 of the RTP calls for the activation of a discrete malfunction six times, and for the calling up of maps twice. Thus, RTP leg 6 was chosen as the vehicle for the dynamic testing.

In both the static and dynamic test phases, the operators were assigned values of 1.0 for their speed and accuracy factors, and 2.5 for their stress threshold factors. These are the values Siegel and Wolf consider to be average for an operator.[1]

The crucial point of the evaluation was actually the dynamic phase. One time was assigned to the RTP leg 6. It was then run three times, each run containing the parameter set values for a different interface device used to activate discrete malfunctions.

The effect the different interface methods had on the total performance of the mission surfaced in the stress levels of the operators, the average time necessary for completion of the leg of the mission and the number of successful missions per run. This procedure was then repeated implementing the candidate interface methods in the mapping display tasks of RTP leg 6.

4.1.3.2 Suitability Test and Results. The candidate methods which were subjected to evaluation were:

(a) Keyboard/CRT action

(b) Push button/CRT action

(c) Light pen/CRT action.

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[1] Siegel, A., Wolf, J., et al. Modification of the Siegel-Wolf Operator Simulation Model for On-Line Experimentation. Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, June 1971.

These methods were evaluated with respect to their suitability to perform two common instructor tasks, activating discrete malfunctions and arranging mapping displays. For a description of paramater sets, see Appendix G, PARAMINDX.

4.1.3.2.1 Interfaces/Map Displays. The keyboard TAM was the first to be evaluated (Figure 4-23). Task 1, ATTENTION-GETTER, was not used on the assumption that this was an instructor-paced task. INFORMATION TYPE III (task 52) and READ TYPE III (task 62) were relevant to the evaluation so they were activated while the other types were made dormant. The CRT was adjacent to the keyboard, therefore tasks 10, 11 and 12, VISUALLY ACCESS, were assigned parameter values for distance equal to 12 inches (Appendix G), i.e., a mean access time of 1.78 seconds. MANUAL ACCESS tasks (20 and 21) were assigned a mean time of 1.00 second (distance equalling 12 inches).

The IPTASK was assigned an arbitrary value of 0.1 second, while DISPLAY DELAY (task 70) had a value 1.0 second. INFORMATION TYPE III and READ TYPE III were assigned mean times of 4.0 seconds and 3.0 seconds respectively. Task 30, KEY IN, was assigned a mean time of 1.35 seconds. This task calls up the proper page on the CRT. Task 31, KEY IN, scales and centers the map. This takes between 5 and 12 keystrokes. The time assigned to this task was 3.1 seconds. A total time of 26 seconds was assigned to the mission.

The results of this test were 97 successful missions out of 100 (see Figure 4-24). The greatest mean stress felt was on operator 4 (cognitive). This stress was 1.37, which is well below the operator stress threshold (2.50). The time (in seconds) for completion was 23.1/mean, 3.1/minimum, 36.5/maximum and 5.17/standard.

The keyboard was a suitable interface device for this task.

The push button TAM (Figure 4-25), in order to perform a mapping display task, requires three buttons to be pressed. One button is dedicated to calling up the map to the CRT, a second to scaling the map, and the third to centering the map at the aircraft. A designer would have these buttons grouped together. Such a configuration allows the evaluator to treat these buttons as if each one were isolated. Therefore, the mean time assigned to task 30, DEPRESS PUSH BUTTON, was three times the mean time necessary for one button. This tripled value is 2.7 seconds. The ATTENTION-GETTER (task 1) was not necessary because this TAM was run at the instructor pace. INFORMATION TYPE II and READ TYPE II were activated (tasks 51 and 61). These types represent the information displayed on a push button. Through SAINTs parameter manipulation ability, the completion of task 30 triggered a parameter set change. Tasks 51 and 61 were set dormant, while tasks 52 and 62, INFORMATION and READ TYPE III, were activated. These new information types represent the information displayed on the CRT (maps). VISUAL ACCESS, MANUAL ACCESS, DISPLAY DELAY and IPTASK parameters were kept the same as they were for the keyboard TAM.

The results of this test were 99/100 successful missions (Figure 4-26). Operator 4 (cognitive) felt the greatest mean stress. However, this stress value (1.02) was well below the operator stress threshold (2.50). The time for completion of this TAM averaged 15.9 seconds.

KEYBOARD TAM 18

| | | A | D |
|---|---|---|---|
| 1 | Attention-Getter | | ✓ |
| 10 | Visually Access Display | ✓ | |
| 40 | IPTASK | ✓ | |
| 50 | Information Type I | | ✓ |
| 51 | II | | ✓ |
| 52 | III | ✓ | |
| 53 | IV | | ✓ |
| 60 | Read (Type I) Display | | ✓ |
| 61 | II | | ✓ |
| 62 | III | ✓ | |
| 63 | IV | | ✓ |
| 80 | Decide to Change Display | ✓ | |
| 11 | Visually Access Keyboard | ✓ | |
| 20 | Manually Access Keyboard | ✓ | |
| 30 | Key In (Param. Set Choice) | ✓ | |
| 10 | Visually Access Display | ✓ | |
| 40 | IPTASK | ✓ | |
| 50 | Information Type I | | ✓ |
| 51 | II | | ✓ |
| 52 | III | ✓ | |
| 53 | IV | | ✓ |
| 70 | Display Delay | ✓ | |
| 60 | Read (Type I) Display | | ✓ |
| 61 | II | | ✓ |
| 62 | III | ✓ | |
| 63 | IV | | ✓ |
| 81 | Verify Change has been implemented correctly | ✓ | |
| 12 | Visually Access Keyboard | ✓ | |
| 21 | Manually Access Keyboard | ✓ | |
| 31 | Key <u>INSERT</u> (P.S.) | ✓ | |

Figure 4-23 Keyboard TAM

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK NO | TASK TYPE | TASK ESS | COUNTERS REL | COUNTERS FAIL | COUNTERS SKIP | TIME TASK REALIZED MEAN | TIME TASK REALIZED STD | TIME TASK REALIZED MIN | TIME TASK REALIZED MAX | TIME TASK COMPLETED MEAN | TIME TASK COMPLETED STD | TIME TASK COMPLETED MIN | TIME TASK COMPLETED MAX | TASK STRESS MEAN | TASK STRESS STD | TASK STRESS MIN | TASK STRESS MAX. | TASK COHESIVENESS MEAN | TASK COHESIVENESS STD | TASK COHESIVENESS MIN | TASK COHESIVENESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EQMT | 1 00 | 100 | 4 | 0. | 0 0 | 0 00 | 0 0 | 0 0 | 0 0 | 0 00 | 0 0 | 0 0 | | | | | | | | |
| 10 | MULT | 1. 00 | 188 | 0. | 0. | 5. 8 | 5. 90 | 0. 0 | 12 9 | 7. 0 | 5. 64 | 1. 3 | 14. 0 | | | | | | | | |
| 11 | MULT | 1 00 | 92 | 0 | 0. | 8 4 | 0 76 | 6 2 | 10 0 | 9 8 | 0 67 | 7 7 | 11 3 | 1 56 | 0. 46 | 1. 11 | 2. 20 | 0 10 | 0. 10 | 0. 00 | 0. 23 |
| 12 | MULT | 1 00 | 92 | 0 | 0 | 18 7 | 1 72 | 16 2 | 24 5 | 20. 5 | 1 73 | 18 1 | 28. 4 | 1 15 | 0 05 | 1 02 | 1 27 | 0 00 | 0 00 | 0 00 | 0. 00 |
| 20 | MULT | 1 00 | 92 | 0 | 0 | 9 8 | 0 67 | 7 7 | 11 3 | 10 7 | 0 61 | 8. 7 | 11 9 | 1 12 | 0 43 | 1. 00 | 3 91 | 0 02 | 0 08 | 0 00 | 0 55 |
| 21 | MULT | 1 00 | 92 | 0 | 0 | 20 5 | 1 73 | 18. 1 | 28. 4 | 21 4 | 1 76 | 19 0 | 30 3 | 1 15 | 0 05 | 1 01 | 1 26 | 0 00 | 0 00 | 0. 00 | 0 00 |
| 30 | MULT | 1 00 | 92 | 0 | 0 | 10 7 | 0 61 | 8 7 | 11 9 | 11 8 | 0. 54 | 10 0 | 12 9 | 1 14 | 0 61 | 1. 00 | 5 00 | 0 00 | 0. 00 | 0 00 | 0 00 |
| 31 | MULT | 1 00 | 100 | 0 | 0. | 20. 0 | 5 09 | 0. 0 | 30 3 | 23 1 | 5 17 | 3 1 | 36. 5 | 1 14 | 0 04 | 1 01 | 1 24 | 0 00 | 0 00 | 0. 00 | 0 00 |
| 40 | EQMT | 1 00 | 188. | 0. | 0. | 7 0 | 5. 64 | 1 3 | 14 0 | 7. 1 | 5 64 | 1. 4 | 14 1 | 1 13 | 0 59 | 1 00 | 5. 00 | 0 00 | 0 00 | 0. 00 | 0 00 |
| 50 | MULT | 1 00 | 188. | 0. | 0. | 7. 1 | 5 64 | 1. 4 | 14 1 | 7. 1 | 5. 64 | 1. 4 | 14. 1 | | | | | 0. 00 | 0. 00 | 0 00 | 0 00 |
| 51 | MULT | 1 00 | 188 | 0 | 0 | 7 1 | 5 64 | 1 4 | 14. 1 | 7 1 | 5 64 | 1 4 | 14 1 | 1. 57 | 0 48 | 1. 10 | 2. 28 | 0. 10 | 0. 10 | 0 00 | 0 24 |
| 52 | MULT | 1 00 | 188 | 0 | 0. | 7 1 | 5 64 | 1 4 | 14 1 | 9 9 | 5 12 | 3 3 | 16 9 | 1 57 | 0 48 | 1. 10 | 2. 28 | 0 10 | 0. 10 | 0 00 | 0 24 |
| 53 | MULT | 1 00 | 188. | 0 | 0 | 9 9 | 5 12 | 3 3 | 16 9 | 9 9 | 5. 12 | 3. 3 | 16 9 | 1 57 | 0 48 | 1 10 | 2. 28 | 0. 10 | 0 10 | 0 00 | 0 24 |
| 60 | MULT | 1 00 | 188 | 0 | 0 | 10 4 | 5 62 | 3 3 | 17 9 | 10. 4 | 5 62 | 3 3 | 17 9 | 1 60 | 0 53 | 1 02 | 2 54 | 0. 11 | 0 11 | 0. 00 | 0 29 |
| 61 | MULT | 1 00 | 188 | 0 | 0. | 10 4 | 5 62 | 3 3 | 17 9 | 10. 4 | 5 62 | 3 3 | 17 9 | 1 71 | 0. 64 | 1 02 | 2. 84 | 0 13 | 0 13 | 0. 00 | 0 35 |
| 62 | MULT | 1 00 | 188 | 0 | 0. | 10 4 | 5 62 | 3 3 | 17 9 | 12 7 | 5. 43 | 5. 2 | 22 9 | 1. 71 | 0. 64 | 1. 02 | 2. 84 | 0. 13 | 0 13 | 0 00 | 0. 35 |
| 63 | MULT | 1 00 | 188 | 0 | 0. | 12 7 | 5 43 | 5 2 | 22 9 | 12 7 | 5 43 | 5. 2 | 22. 9 | 1 71 | 0 64 | 1. 02 | 2. 84 | 0 13 | 0. 13 | 0 C0 | 0 35 |
| 70 | EQMT | 1 00 | 92 | 0 | 0. | 15 1 | 0 86 | 12. 6 | 16. 9 | 16. 1 | 0. 85 | 13. 6 | 17. 9 | 1 87 | 0 93 | 1 00 | 5. 00 | 0. 16 | 0. 19 | 0 00 | 0. 76 |
| 80 | SING | 1 00 | 96 | 4 | 0. | 7 6 | 0. 81 | 5 2 | 9 3 | 8 4 | 0. 75 | 6 2 | 10. 0 | 1. 10 | 0 06 | 1 00 | 1 27 | C. 02 | 0. 01 | 0 00 | 0 06 |
| 81 | SING | 1 00 | 92 | 0 | 0 | 18 1 | 1 54 | 15. 6 | 22 9 | 18. 7 | 1. 72 | 16. 2 | 24. 5 | 1. 91 | 0. 34 | 1 50 | 3. 34 | 0. 34 | 0. 34 | 0. 14 | ? 04 |

--- MISSION SUMMARY REPORT. ---

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD | BUSY TIME MIN. | BUSY TIME MAX. | IDLE TIME MEAN | IDLE TIME STD | IDLE TIME MIN. | IDLE TIME MAX. | TOTAL TIME USED MEAN | TOTAL TIME USED STD. | TOTAL TIME USED MIN | TOTAL TIME USED MAX. | STRESS MEAN | STRESS STD. | STRESS MIN | STRESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 26 00 | 20 6 | 4 6 | 3. 1 | 32 8 | 2 5 | 0. 6 | 0. 0 | 3. 6 | 23. 1 | 5 2 | 3. 1 | 36. 5 | 1. 32 | 0. 24 | 1. 00 | 2 76 |
| 2 | 26 00 | 5 7 | 1 0 | 3 1 | 9. 9 | 17. 4 | 4 4 | 0 0 | 26 6 | 23. 1 | 5 2 | 3. 1 | 36 5 | 0. 62 | 0. 18 | 0. 25 | 1 60 |
| 3 | 26 00 | 5 7 | 1 0 | 3 1 | 9 9 | 17. 4 | 4 4 | 0 0 | 26. 6 | 23. 1 | 5 2 | 3. 1 | 36. 5 | 0. 62 | 0. 18 | 0. 25 | 1 60 |
| 4 | 26. 00 | 22 0 | 4. 9 | 3. 1 | 35. 3 | 1. 1 | 0. 3 | 0. 0 | 1. 2 | 23. 1 | 5. 2 | 3. 1 | 36. 5 | 1. 37 | 0. 23 | 1. 00 | 2. 73 |

97 SUCCESSFUL MISSIONS

3 UNSUCCESSFUL MISSIONS

Figure 4-24 Keyboard Report

## PUSHBUTTON TAM (MAP)

| | | A | D |
|---|---|---|---|
| 1 | Attention-Getter | | ✓ |
| 80 | Decide to Access Push button | ✓ | |
| 10 | Visually Access (Unique/Nonunique) P.B. | ✓ | |
| 40 | IPTASK | ✓ | |
| 50 | Information Type I | | ✓ |
| 51 | II | ✓ | |
| 52 | III | | ✓ |
| 53 | IV | | ✓ |
| 60 | Read (Type I) P.B. | | ✓ |
| 61 | II | ✓ | |
| 62 | III | | ✓ |
| 63 | IV | | ✓ |
| 20 | Manually Access P.B. | ✓ | |
| 30 | Depress Push button | ✓ | |
| 40 | IPTASK | ✓ | |
| 50 | Information Type I | | ✓ |
| 51 | II | | ✓ |
| 52 | III | ✓ | |
| 53 | IV | | ✓ |
| 70 | Display Delay | ✓ | |
| 60 | Read (Type I) Push button | | ✓ |
| 61 | II | | ✓ |
| 62 | III | ✓ | |
| 63 | IV | | ✓ |
| 81 | Verify | ✓ | |
| 10 | Eyes to Remote Display | ✓ | |
| 40 | IETAM | ✓ | |
| 50 | Information Type I | | ✓ |
| 51 | II | | ✓ |
| 52 | III | ✓ | |
| 53 | IV | | ✓ |
| 70 | Display Delay | ✓ | |
| 60 | Read (Type I) Display | | ✓ |
| 61 | II | | ✓ |
| 62 | III | ✓ | |
| 63 | IV | | ✓ |
| 81 | Verify change has been correctly implemented | ✓ | |

Figure 4-25 Push Button TAM

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK NO | TASK TYPE | TASK ESS | COUNTERS REL | COUNTERS FAIL | COUNTERS SKIP | TIME TASK REALIZED MEAN | TIME TASK REALIZED STD | TIME TASK REALIZED MIN | TIME TASK REALIZED MAX | TIME TASK COMPLETED MEAN | TIME TASK COMPLETED STD | TIME TASK COMPLETED MIN. | TIME TASK COMPLETED MAX | TASK STRESS MEAN | TASK STRESS STD. | TASK STRESS MIN. | TASK STRESS MAX. | TASK COHESIVENESS MEAN | TASK COHESIVENESS STD. | TASK COHESIVENESS MIN. | TASK COHESIVENESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EQMT | 1.00 | 100. | 3. | 0. | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | | | | | | | | |
| 10 | MULT | 1.00 | 188. | 0. | 0. | 3.[illegible] | 3.28 | 0.9 | 30.2 | 5.4 | 3.37 | 2.4 | 34.5 | 1.03 | 0.30 | 1.00 | 5.00 | 0.03 | 0.33 | 0.00 | 4.57 |
| 20 | MULT | 1.00 | 95 | 0 | 0 | 5.3 | 2.95 | 4.4 | 31.0 | 6.3 | 3.03 | 5.4 | 32.9 | 1.05 | 0.41 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 30 | MULT | 1.00 | 95 | 0. | 0. | 6.3 | 3.03 | 5.4 | 32.9 | 6.2 | 2.78 | 5.4 | 30.2 | 1.05 | 0.41 | 1.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 40 | EQMT | 1.00 | 188 | 0 | 0 | 5.4 | 3.37 | 2.4 | 34.5 | 5.5 | 3.37 | 2.5 | 34.6 | | | | | | | | |
| 50 | MULT | 1.00 | 189 | 0 | 0 | 5.5 | 3.37 | 2.5 | 34.6 | 5.5 | 3.37 | 2.5 | 34.6 | 1.03 | 0.30 | 1.00 | 5.00 | 0.03 | 0.33 | 0.00 | 4.57 |
| 51 | MULT | 1.00 | 188 | 0 | 0. | 5.5 | 3.37 | 2.5 | 34.6 | 6.0 | 3.00 | 3.5 | 34.6 | 1.03 | 0.30 | 1.00 | 5.00 | 0.03 | 0.33 | 0.00 | 4.57 |
| 52 | MULT | 1.00 | 188 | 0 | 0 | 6.0 | 3.00 | 3.5 | 34.6 | 8.0 | 4.80 | 3.5 | 42.7 | 1.03 | 0.30 | 1.00 | 5.00 | 0.03 | 0.33 | 0.00 | 4.57 |
| 53 | MULT | 1.00 | 188 | 0. | 0. | 8.0 | 4.80 | 3.5 | 42.7 | 8.0 | 4.80 | 3.5 | 42.7 | 1.03 | 0.32 | 1.00 | 5.00 | 0.03 | 0.33 | 0.00 | 4.57 |
| 60 | MULT | 1.00 | 188 | 0. | 0. | 8.6 | 5.24 | 3.5 | 43.7 | 8.6 | 5.24 | 3.5 | 43.7 | 1.04 | 0.34 | 1.00 | 5.00 | 0.03 | 0.33 | 0.00 | 4.57 |
| 61 | MULT | 1.00 | 188 | 0 | 0 | 8.6 | 5.24 | 3.5 | 43.7 | 9.0 | 4.81 | 4.4 | 43.7 | 1.04 | 0.34 | 1.00 | 5.00 | 0.03 | 0.33 | 0.00 | 4.57 |
| 62 | MULT | 1.00 | 188 | 0. | 0. | 9.0 | 4.81 | 4.4 | 43.7 | 10.6 | 6.29 | 4.4 | 48.1 | 1.03 | 0.33 | 1.00 | 5.00 | 0.03 | 0.33 | 0.00 | 4.57 |
| 63 | MULT | 1.00 | 188. | 0 | 0. | 10.6 | 6.29 | 4.4 | 48.1 | 10.6 | 6.29 | 4.4 | 48.1 | 1.13 | 0.42 | 1.00 | 5.00 | 0.05 | 0.34 | 0.00 | 4.57 |
| 70 | EQMT | 1.00 | 95 | 0 | 0. | 12.1 | 3.41 | 9.7 | 42.7 | 13.1 | 3.41 | 10.7 | 43.7 | | | | | | | | |
| 80 | SING | 1.00 | 97 | 4 | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 1.0 | 0.05 | 0.9 | 1.1 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 81 | SING | 1.00 | 95 | 2 | 0 | 16.2 | 3.74 | 13.4 | 48.1 | 17.2 | 3.86 | 14.4 | 50.2 | 1.14 | 0.57 | 1.00 | 5.00 | 0.11 | 0.66 | 0.00 | 4.57 |
| 100 | EQMT | 1.00 | 100 | 0 | 0. | 15.9 | 5.48 | 0.0 | 50.2 | 15.9 | 5.48 | 0.0 | 50.2 | | | | | | | | |

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD | BUSY TIME MIN | BUSY TIME MAX | IDLE TIME MEAN | IDLE TIME STD. | IDLE TIME MIN | IDLE TIME MAX. | TOTAL TIME USED MEAN | TOTAL TIME USED STD. | TOTAL TIME USED MIN | TOTAL TIME USED MAX | STRESS MEAN | STRESS STD | STRESS MIN | STRESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 26.00 | 12.9 | 4.6 | 0.0 | 40.9 | 2.1 | 0.8 | 0.0 | 7.2 | 15.0 | 5.4 | 0.0 | 48.1 | 0.93 | 0.25 | 0.00 | 2.83 |
| 2 | 26.00 | 0.9 | 0.3 | 0.0 | 1.1 | 4.8 | 2.8 | 0.0 | 29.4 | 5.7 | 2.9 | 0.0 | 30.2 | 0.73 | 0.08 | 0.66 | 1.00 |
| 3 | 26.00 | 0.9 | 0.3 | 0.0 | 1.1 | 4.8 | 2.8 | 0.0 | 29.4 | 5.7 | 2.9 | 0.0 | 30.2 | 0.73 | 0.08 | 0.66 | 1.00 |
| 4 | 26.00 | 14.7 | 5.1 | 0.0 | 46.7 | 1.1 | 0.4 | 0.0 | 3.4 | 15.9 | 5.5 | 0.0 | 50.2 | 1.02 | 0.21 | 1.00 | 3.07 |

99 SUCCESSFUL MISSIONS

1 UNSUCCESSFUL MISSIONS

Figure 4-26 Push Button Report

4.1.3.2.1 Interfaces/Map Displays (Cont'd)

The minimum time of 0.0 seconds was due to the possibility that the desired display was already on the CRT and no changes were needed.

The use of the light pen (Figure 4-27) to arrange a mapping display consisted of calling up a map from a menu page, choosing a scale (the scale factors were assumed to be on the map itself) and moving a cursor in order to center the map on the aircraft. These actions were incorporated into tasks 30, 31, and 32. As in the two previous TAMs, INFORMATION TYPE III and READ TYPE III were active. The MANUAL ACCESS, VISUAL ACCESS, IPTASK, and DISPLAY DELAY times were the same as in the two previous TAMs. A time of 26 seconds was allotted for this TAM.

The results of the running of the light pen TAM with the preceding data were 62 successful missions out of 100 (see Figure 4-28). The time (in seconds) for completion was 31.1/mean, 0/minimum, 130.9/maximum and 23.39/standard.

The mean stress on both the visual and cognitive operators (3.49 and 3.64) exceeded their stress thresholds (2.50).

Table 4-9 presents a summary of the values obtained for each candidate interface method.

Table 4-9 Value Summary

| | Keyboard | Push Button | Light Pen |
|---|---|---|---|
| Mean time of completion (seconds) | 23.1 | 15.9 | 31.1 |
| Maximum Average stress | 1.37 | 1.02 | 3.64* and 3.49* |
| Successful missions/100 | 97 | 99 | 62 |
| Time allotted for mission (seconds) | 26.0 | 26.0 | 26.0 |

* NOTE: Both these values exceed the operator stress threshold. The least suitable device was the light pen. While the other two interface methods were able to allow the tasks to be completed in under 26 seconds, while never reaching the opeator stress thresholds, the light pen method exceeded both the allotted time and the operator stress threshold.

While the keyboard showed itself to be an acceptable interface method for these tasks, the push button method was preferable. It required 7.2 seconds less to perform the mapping task by push button than by keyboard and, while both techniques did not stress the operators greatly, the push button method results in the lower stress value.

LIGHT PEN (SINGLE/MULTIPLE TARGET/MODIFY COMPLEX DISPLAY) TAM 10

| | | A | B |
|---|---|---|---|
| 1 | Attention-Getter | | ✓ |
| 80 | Decide to change display | ✓ | |
| 10 | Visually Access Pen | ✓ | |
| 20 | Manually Access Pen | ✓ | |
| 11 | Visually Access Display | ✓ | |
| 40 | IPTASK | ✓ | |
| 50 | Information Type I | | ✓ |
| 51 | II | | ✓ |
| 52 | III | ✓ | |
| 53 | IV | | ✓ |
| 60 | Read (Type I) Display | | ✓ |
| 61 | II | | ✓ |
| 62 | III | ✓ | |
| 63 | IV | | ✓ |
| 30 | Position Pen | ✓ | |
| 31 | Aim Pen | ✓ | |
| 32 | Activate (Single/Multiple/Target/Complex) Displays | ✓ | |
| 11 | Visually Access Display | ✓ | |
| 40 | IPTASK | ✓ | |
| 50 | Information Type I | | ✓ |
| 51 | II | | ✓ |
| 52 | III | ✓ | |
| 53 | IV | | ✓ |
| 70 | Display Delay | ✓ | |
| 60 | Read (Type I) Changed Display | | ✓ |
| 61 | II | | ✓ |
| 62 | III | ✓ | |
| 63 | IV | | ✓ |
| 11 | Visually Access Remote Feedback Display | ✓ | |
| 40 | IPTASK | | ✓ |
| 50 | Information Type I | | ✓ |
| 51 | II | | ✓ |
| 52 | III | ✓ | |
| 53 | IV | | ✓ |
| 70 | Display Delay | ✓ | |
| 60 | Read (Type I) Display | | ✓ |
| 61 | II | | ✓ |
| 62 | III | ✓ | |
| 63 | IV | | ✓ |
| 81 | Verify | ✓ | |

Figure 4-27 Light Pen TAM

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK NO | TASK TYPE | TA I ESS | -- COUNTERS--- RLI | FAIL | SKIP | -----TIME TASK REALIZED---- MEAN | STD | MIN | MAX | ----TIME TASK COMPLETED---- MEAN | STD | MIN | MAX | ---TASK STRESS---- MEAN | STD | MIN. | MAX | -TASK COHESIVENESS- MEAN | STD | MIN | MAX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EQMT | 1 00 | 100 | 5 | 0 | 0 0 | 0 00 | 0 0 | 0 0 | 0 0 | 0.00 | 0.0 | 0.0 | | | | | | | | |
| 10 | MULT | 1 00 | 91 | 0 | 0 | 1 0 | 0 05 | 0 9 | 1 1 | 2.8 | 0 17 | 2 4 | 3 1 | 1 00 | 0 00 | 1.00 | 1.01 | 0.00 | 0 00 | 0.00 | 0 00 |
| 11 | MULT | 1 00 | 217 | 0 | 0 | 16 0 | 18 23 | 3 5 | 108 7 | 18 5 | 13 74 | 5 1 | 111 4 | 2 15 | 1 37 | 1.00 | 5 00 | 0 22 | 0 26 | 0 00 | 0 76 |
| 20 | MULT | 1 00 | 91 | 0 | 0 | 2 8 | 0 17 | 2.4 | 3 1 | 4.7 | 0 79 | 3 5 | 6.1 | 1 00 | 0 01 | 1 00 | 1 02 | 0.00 | 0.00 | 0 00 | 0 00 |
| 30 | MULT | 1 00 | 91 | 0 | 0 | 13 3 | 1 03 | 9 6 | 15 6 | 13.3 | 1 03 | 9 6 | 15 6 | 1 03 | 0 05 | 1.00 | 1.22 | 0.00 | 0 00 | 0 00 | 0.00 |
| 31 | MULT | 1 00 | 91 | 0 | 0 | 13 3 | 1 03 | 9 6 | 15 6 | 14 2 | 0 99 | 10 4 | 16 2 | 1 03 | 0 05 | 1.00 | 1 22 | 0 00 | 0 00 | 0 00 | 0 00 |
| 32 | MULT | 1 00 | 91 | 0 | 0 | 14 2 | 0 99 | 10 4 | 16 2 | 16 2 | 0 93 | 12 6 | 17 7 | 1 03 | 0 05 | 1 00 | 1 19 | 0 00 | 0.00 | 0 00 | 0 00 |
| 40 | EQMT | 1 00 | 217 | 0 | 0 | 18 5 | 18 74 | 5 1 | 111 4 | 18 6 | 18 74 | 5 2 | 111 5 | | | | | | | | |
| 50 | MULT | 1 00 | 217 | 0 | 0 | 18 6 | 18 74 | 5 2 | 111 5 | 18 6 | 18 74 | 5 2 | 111 5 | 2 19 | 1 38 | 1 00 | 5.00 | 0.23 | 0 26 | 0 00 | 0.76 |
| 51 | MULT | 1 00 | 217 | 0 | 0 | 18 6 | 18 74 | 5 2 | 111 5 | 18 6 | 18 74 | 5 2 | 111 5 | 2.19 | 1 38 | 1.00 | 5.00 | 0 23 | 0 26 | 0.00 | 0 76 |
| 52 | MULT | 1 00 | 217 | 0 | 0 | 18 6 | 18 74 | 5 2 | 111 5 | 22 7 | 20 20 | 7 8 | 121 9 | 2 19 | 1 38 | 1.00 | 5.00 | 0 23 | 0 26 | 0 00 | 0 76 |
| 53 | MULT | 1 00 | 217 | 0 | 0 | 22 7 | 20 20 | 7 8 | 121 9 | 22 7 | 20 20 | 7.8 | 121 9 | 2 38 | 1 51 | 1 00 | 5.00 | 0 26 | 0 29 | 0 00 | 0 76 |
| 60 | MULT | 1 00 | 217 | 0 | 0 | 23 2 | 20 46 | 7 8 | 122 9 | 23.2 | 20 46 | 7 8 | 122 9 | 2 55 | 1 55 | 1 00 | 5.00 | 0 29 | 0 29 | 0 00 | 0 76 |
| 61 | MULT | 1 00 | 217 | 0 | 0 | 23 2 | 20 46 | 7 8 | 122 9 | 23 2 | 20 46 | 7 8 | 122 9 | 2 55 | 1 55 | 1 00 | 5 00 | 0.29 | 0 29 | 0.00 | 0 76 |
| 62 | MULT | 1 00 | 217 | 0 | 0 | 23 2 | 20 46 | 7 8 | 122 9 | 27 1 | 21.38 | 9 6 | 128 6 | 2 55 | 1 55 | 1.00 | 5.00 | 0 29 | 0 29 | 0 00 | 0 76 |
| 63 | MULT | 1 00 | 217 | 0 | 0 | 27 1 | 21 38 | 9 6 | 128 8 | 27 1 | 21.38 | 9 6 | 128 8 | 3 06 | 1 87 | 1 00 | 5.00 | 0.39 | 0 36 | 0 00 | 0.76 |
| 70 | EQMT | 1 00 | 126 | 0 | 0. | 31 5 | 22 74 | 15 7 | 121 9 | 32 5 | 22 74 | 16.7 | 122 9 | | | | | | | | |
| 80 | SING | 1 00 | 95 | 4 | 0 | 0 0 | 0 00 | 0.0 | 0 0 | 1 0 | 0 05 | 0 9 | 1 1 | 1 00 | 0 00 | 1 00 | 1.00 | 0 00 | 0 00 | 0 00 | 0 00 |
| 81 | SING | 1 00 | 126 | 35 | 0 | 37 1 | 23 44 | 17 7 | 126 8 | 38 5 | 23 86 | 18.4 | 130 9 | 3 68 | 1 51 | 1.28 | 5.00 | 2.82 | 2 00 | 0 08 | 4 57 |
| 100 | EQMT | 1 00 | 100 | 0 | 0 | 31 1 | 23 39 | 0 0 | 130 9 | 31 1 | 23.39 | 0.0 | 130 9 | | | | | | | | |

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | ---------BUSY TIME--------- MEAN | STD | MIN | MAX | ---------IDLE TIME--------- MEAN | STD | MIN | MAX | ------TOTAL TIME USED------ MEAN | STD | MIN. | MAX | --------STRESS-------- MEAN | STD. | MIN | MAX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 26 00 | 26 9 | 19 9 | 0 0 | 110 6 | 3 1 | 3 2 | 0 0 | 18.2 | 30.0 | 22 9 | 0.0 | 128 8 | 1.71 | 0 92 | 0 00 | 4 23 |
| [illegible] | 26 00 | 4 3 | 1 5 | 0 0 | 6 4 | 10 4 | 3 4 | 0 0 | 13 8 | 14.7 | 4 7 | 0 0 | 17 7 | 0.91 | 0.04 | 0.86 | 1 00 |
| 3 | 26 00 | 4 3 | 1 5 | 0 0 | 6 4 | 10 4 | 3 4 | 0 0 | 13.8 | 14 7 | 4 7 | 0 0 | 17 7 | 0.91 | 0.04 | 0 86 | 1 00 |
| 4 | 26 00 | 29 6 | 22 3 | 0 0 | 124 2 | 1 5 | 1 1 | 0.0 | 6 7 | 31 1 | 23 4 | 0.0 | 130 9 | 1 90 | 0.89 | 1 00 | 4 32 |

62 SUCCESSFUL MISSIONS

38 UNSUCCESSFUL MISSIONS

Figure 4-28 Light Pen Report

This, however, was not the complete picture. The devices were then tested dynamically as an integral part of the IOS console. These tests are described in paragraph 4.1.3.3.

4.1.3.2.2 Interfaces/Activates Discrete Malfunctions. The keyboard TAM (Figure 4-29), when used to perform the task of activating a discrete malfunction, contains the same parameter as it did for mapping displays, with the exception of tasks 30, 31 and information and read types. Task 30, KEY IN, called for the instructor to display the malfunction page and to address a line. This was done using a series of five keystrokes. According to PARAMINDX (Appendix G), a mean time of 1.35 seconds was assigned to this task. Task 31, KEY INSERT, consisted of depressing an isolated push button on the keyboard and was assigned a time of 0.02 seconds. INFORMATION TYPE II and READ TYPE II (tasks 51 and 61) were activated. A time of 17 seconds was assigned for this mission.

The results of running this TAM with the preceding data were 97% successful (see Figure 4-30). The greatest mean stress felt was on operator 4 (1.29) This value was 1.21 lower than the operator stress threshold. The time for completion of the mission (in seconds) as 14.4/mean, 12.1/minimum, 72.5/maximum and 7.67/standard.

The push button TAM (Figure 4-31) was a simple one button operation. The malfunctions were printed on the dedicated push buttons which were arranged in a bank. When the malfunction was activated, the button color changed. As a result of this, there was no need for the instructor to look to the CRT to verify that the change was implemented. There was no parameter modification of the INFORMATION TYPE II and READ TYPE II tasks, as when a push button interface was used to call up a mapping display. The interface itself was used to verify that the change had been made. Task 10, VISUALLY ACCESS PUSH BUTTON, was assigned a time of 1.78 seconds. Task 20, MANUALLY ACCESS PUSH BUTTON, had a time of 2.1 seconds and described the time taken to position the instructor finger over the correct malfunction button. The actual depression of the button took 0.02 seconds. A total time of 15 seconds was allowed for completion of the TAM.

This TAM yielded 99 successful missions (Figure 4-32). The maximum stress on an operator was 1.07 on operator 4. The time required for completion of this TAM (in seconds) was 10.4/mean, 0/minimum, 32/maximum and 3.44/standard.

The light pen TAM (Figure 4-33) assumed that the malfunction page was already displayed on the CRT. The instructor needed only to touch the light pen to the CRT area sensitive to the activation of the desired malfunction. This TAM yielded 95/100 successful missions (Figure 4-34). The average stress on an operator was highest on operator 4 (1.08). The time required for completion of this TAM was 11.4 seconds.

The minimum time of 0.0 seconds represents the possibility that the malfunction was already active.

KEYBOARD TAM (MAP)

| | | A | D |
|---|---|---|---|
| 1 | Attention-Getter | | ✓ |
| 10 | Visually Access Display | ✓ | |
| 40 | IPTASK | ✓ | |
| 50 | Information Type I | | ✓ |
| 51 | II | | ✓ |
| 52 | III | ✓ | |
| 53 | IV | | ✓ |
| 60 | Read (Type I) Display | | ✓ |
| 61 | II | | ✓ |
| 62 | III | ✓ | |
| 63 | IV | | ✓ |
| 80 | Decide to Change Display | ✓ | |
| 11 | Visually Access Keyboard | ✓ | |
| 20 | Manualy Access Keyboard | ✓ | |
| 30 | Key In (Param. Set Choice) | ✓ | |
| 10 | Visually Access Display | ✓ | |
| 40 | IPTASK | ✓ | |
| 50 | Information Type I | | ✓ |
| 51 | II | | ✓ |
| 52 | III | ✓ | |
| 53 | IV | | ✓ |
| 70 | Display Delay | ✓ | |
| 60 | Read (Type I) Display | | ✓ |
| 61 | II | | ✓ |
| 62 | III | ✓ | |
| 63 | IV | | ✓ |
| 81 | Verify Change has been implemented correctly | ✓ | |
| 12 | Visually Access Keyboard | ✓ | |
| 21 | Manually Access Keyboard | ✓ | |
| 31 | Key INSERT (P.S.) | ✓ | |

Figure 4-29 Keyboard TAM

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK NO | [illegible] | LAS | [illegible] | COUNTERS FAIL | SKIP | TIME TASK REALIZED MEAN | STD | MIN | MAX | TIME TASK COMPLETED MEAN | STD | MIN | MAX | TASK STRESS MEAN | STD | MIN | MAX | TASK COMPLETENESS MEAN | STD | MIN | MAX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | [illegible] | [illegible] | 100 | 1 | 0 | 0 0 | 0 00 | 0 0 | 0 0 | 0 0 | 0 00 | 0 0 | 0 0 | | | | | | | | |
| 10 | [illegible] | [illegible] | 175 | 0 | 0 | 5 0 | 6 81 | 0 0 | 61 4 | 6 4 | 6 77 | 1 5 | 65 4 | 1 55 | 0 71 | 1 00 | 5 00 | 0 18 | 0 64 | 0 00 | 4 57 |
| 11 | [illegible] | [illegible] | 97 | 0 | 0 | 5 9 | 5 86 | 4 5 | 53 0 | 7 7 | 6 09 | 6 1 | 56 5 | 1 15 | 0 71 | 1 00 | 5 00 | 0 11 | 0 66 | 0 00 | 4 57 |
| [illegible] | [illegible] | [illegible] | 92 | 0 | 0 | 13 0 | 6 56 | 12 1 | 75 5 | 15 6 | 6 81 | 13 6 | 76 4 | 1 09 | 0 59 | 1 00 | 5 00 | 0 10 | 0 67 | 0 00 | 4 57 |
| [illegible] | [illegible] | [illegible] | 95 | 0 | 0 | 7 7 | 6 09 | 6 1 | 56 5 | 8 7 | 6 27 | 7 1 | 58 7 | 1 17 | 0 00 | 1 00 | 5 00 | 0 00 | 0 00 | 0 00 | 0. 00 |
| [illegible] | [illegible] | [illegible] | [illegible] | 0 | 0 | 15 6 | 6 81 | 13 6 | 76 4 | 16 6 | 6 95 | 14. 5 | 78 2 | 1 09 | 0 59 | 1 00 | 5 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| 30 | [illegible] | [illegible] | [illegible] | [illegible] | 0 | 8 7 | 6 27 | 7 1 | 58 7 | 10 1 | 6 50 | 8 4 | 61 4 | 1 17 | 0 00 | 1 00 | 5 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| 31 | [illegible] | [illegible] | 100 | 0 | 0 | 15 6 | 7 50 | 0 0 | 78 2 | 15 7 | 7 50 | 0 0 | 78 2 | 1 12 | 0 69 | 1 00 | 5 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| 40 | [illegible] | [illegible] | [illegible] | 0 | 0 | 6 4 | 6 77 | 1 5 | 65 4 | 6 5 | 6 77 | 1 6 | 65 5 | | | | | | | | |
| 50 | [illegible] | [illegible] | [illegible] | 0 | 0 | 6 5 | 6 77 | 1 6 | 65 5 | 6 5 | 6 77 | 1 5 | 65 5 | 1 58 | 0 72 | 1 00 | 5 00 | 0 19 | 0 64 | 0 00 | 4 57 |
| 51 | [illegible] | [illegible] | 195 | 0 | 0 | 6 5 | 6 77 | 1 6 | 65 5 | 7 3 | 6 78 | 2 5 | 67 6 | 1 58 | 0 72 | 1 00 | 5 00 | 0 19 | 0 64 | 0 00 | 4 57 |
| 52 | [illegible] | [illegible] | [illegible] | 0 | 0 | 7 3 | 6 78 | 2 5 | 67 6 | 7 3 | 6 78 | 2 5 | 67 6 | 1 59 | 0 73 | 1 00 | 5 00 | 0 19 | 0 64 | 0 00 | 4 57 |
| 53 | [illegible] | [illegible] | [illegible] | 0 | 0 | 7 3 | 6 78 | 2 5 | 67 6 | 7 3 | 6. 78 | 2 5 | 67 6 | 1 59 | 0 73 | 1 00 | 5 00 | 0 19 | 0 64 | 0 00 | 4 57 |
| 60 | [illegible] | [illegible] | 175 | 0 | 0 | 7 8 | 7 13 | 2 5 | 68 6 | 7 8 | 7 13 | 2 5 | 68 6 | 1 78 | 0 87 | 1 00 | 5 00 | 0 23 | 0 65 | 0 00 | 4 57 |
| 61 | [illegible] | [illegible] | 175 | 0 | 0 | 7 8 | 7 13 | 2 5 | 68 6 | 8 8 | 7 18 | 3 5 | 70 6 | 1 78 | 0 87 | 1 00 | 5 00 | 0 23 | 0 65 | 0 00 | 4 57 |
| 62 | [illegible] | [illegible] | 175 | 0 | 0 | 8 8 | 7 18 | 3 5 | 70 [illegible] | 8 8 | 7 18 | 3 5 | 70 6 | 1 89 | 0 99 | 1 00 | 5 00 | 0 25 | 0 65 | 0 00 | 4 57 |
| 63 | [illegible] | [illegible] | 175 | 0 | 0 | 9 0 | 7 18 | 3 5 | 70 6 | 8 8 | 7 18 | 3 5 | 70 6 | 1 89 | 0 99 | 1 00 | 5 00 | 0 25 | 0 65 | 0 00 | 4 57 |
| 70 | [illegible] | [illegible] | [illegible] | 0 | 0 | 11 7 | 7 19 | 10 0 | 67 6 | 12 9 | 7 19 | 11 0 | 68 6 | | | | | | | | |
| 80 | [illegible] | [illegible] | 107 | [illegible] | 0 | 4 8 | 5 46 | 3 5 | 51 3 | 5 8 | 5 66 | 4 5 | 53 8 | 1 12 | 0 63 | 1 00 | 5 00 | 0 10 | 0 64 | 0 00 | 4 57 |
| 81 | [illegible] | [illegible] | [illegible] | [illegible] | 0 | 13 8 | 7 41 | 11 6 | 70 6 | 14 4 | 7 67 | 12 1 | 72 5 | 1 97 | 0 66 | 1 60 | 5 00 | 0 43 | 0 87 | 0 17 | 4 57 |

MISSION SUMMARY REPORT

| [illegible] | [illegible] | BUSY TIME MEAN | STD | MIN | MAX | IDLE TIME MEAN | STD | MIN | MAX | TOTAL TIME USED MEAN | STD | MIN | MAX | STRESS MEAN | STD | MIN | MAX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | 12 9 | 5 8 | 0 0 | 59 8 | 2 8 | 1 7 | 0 0 | 18 4 | 15 7 | 7 5 | 0 0 | 78 2 | 1 27 | 0 39 | 1 00 | 4 29 |
| [illegible] | [illegible] | 3 3 | 1 8 | 0 0 | 17 6 | 12 4 | 5 7 | 0 0 | 60 6 | 15 7 | 7 5 | 0 0 | 78 2 | 0 60 | 0 46 | 0 00 | 4 05 |
| [illegible] | [illegible] | 3 3 | 1 8 | 0 0 | 17 6 | 12 4 | 5 7 | 0 0 | 60 6 | 15 7 | 7 5 | 0 0 | 78 2 | 0 60 | 0 46 | 0 00 | 4 05 |
| [illegible] | [illegible] | 14 5 | 7 1 | 0 0 | [illegible]3 7 | 1 2 | 0 5 | 0 0 | 4 5 | 15 7 | 7 5 | 0 0 | 78 2 | 1 29 | 0 40 | 1 00 | 4 33 |

97 SUCCESSFUL MISSIONS

3 UNSUCCESSFUL MISSIONS

Figure 4-30 Keyboard Report

## PUSHBUTTON TAM 20

| | | A | D |
|---|---|---|---|
| 1 | Attention-Getter | | ✓ |
| 80 | Decide to Access Push button | ✓ | |
| 10 | Visually Access (Unique/Nonunique) P.B. | ✓ | |
| 40 | IPTASK | ✓ | |
| 50 | Information Type I | | ✓ |
| 51 | II | ✓ | |
| 52 | III | | ✓ |
| 53 | IV | | ✓ |
| 60 | Read (Type I) P.B. | | ✓ |
| 61 | II | ✓ | |
| 62 | III | | ✓ |
| 63 | IV | | ✓ |
| 20 | Manually Access P.B. | ✓ | |
| 30 | Depress Push button | ✓ | |
| 40 | IPTASK | ✓ | |
| 50 | Information Type I | | ✓ |
| 51 | II | | ✓ |
| 52 | III | ✓ | |
| 53 | IV | | ✓ |
| 70 | Display Delay | ✓ | |
| 60 | Read (Type I) Push button | | ✓ |
| 61 | II | | ✓ |
| 62 | III | ✓ | |
| 63 | IV | | ✓ |
| 81 | Verify | ✓ | |
| 10 | Eyes to Remote Display | ✓ | |
| 40 | IETAM | ✓ | |
| 50 | Information Type I | | ✓ |
| 51 | II | | ✓ |
| 52 | III | ✓ | |
| 53 | IV | | ✓ |
| 70 | Display Delay | ✓ | |
| 60 | Read (Type I) Display | | ✓ |
| 61 | II | | ✓ |
| 62 | III | ✓ | |
| 63 | IV | | ✓ |
| 81 | Verify change has been correctly implemented | ✓ | |

Figure 4-31 Push Button TAM

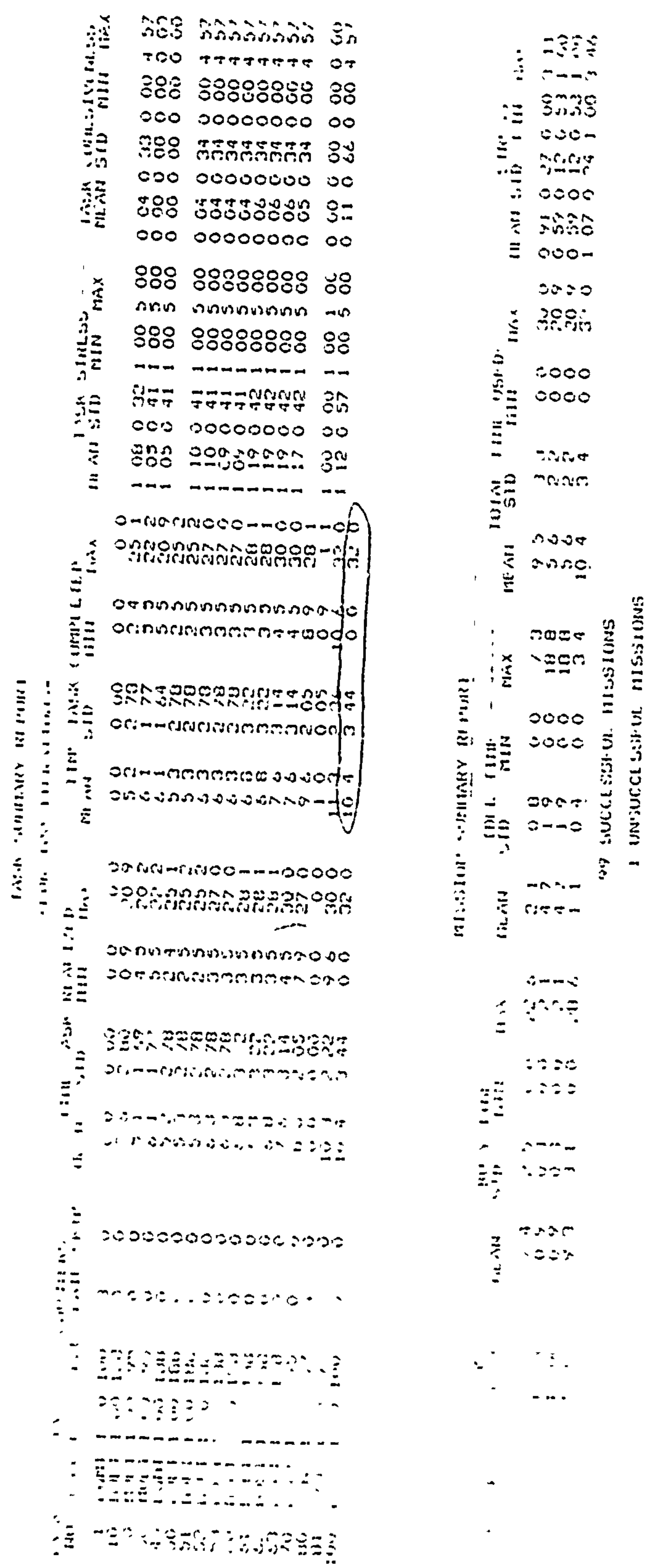


Figure 4-32  Push Button Report

## LIGHT PEN (SINGLE/MULTIPLE TARGET//MODIFY COMPLEX DISPLAY) TAM 10

| | | A D |
|---|---|---|
| 1 | Attention-Getter | |
| 80 | Decide to change display | |
| 10 | Visually Access | |
| 20 | Manually Access | |
| 11 | Visually Access Display | |
| 40 | IPTASK | |
| 50 | Information Type I | |
| 51 | Information Type II | |
| 52 | Information Type III | |
| 53 | Information Type IV | |
| 60 | Read (Type I) Display | |
| 61 | Read (Type II) Display | |
| 62 | Read (Type III) Display | |
| 63 | Read (Type IV) Display | |
| 30 | Position | |
| 31 | Aim | |
| 32 | Activate (Single/Multiple/Target/Complex) Displays | |
| 40 | IPTASK | |
| 50 | Information Type I | |
| 51 | Information Type II | |
| 52 | Information Type III | |
| 53 | Information Type IV | |
| 70 | Display Delay | |
| 60 | Read (Type I) Changed Display | |
| 61 | Read (Type II) Changed Display | |
| 62 | Read (Type III) Changed Display | |
| 63 | Read (Type IV) Changed Display | |
| 11 | Visually Access Remote Feedback Display | |
| 40 | IPTASK | |
| 50 | Information Type I | |
| 51 | Information Type II | |
| 52 | Information Type III | |
| 53 | Information Type IV | |
| 70 | Display Delay | |
| 60 | Read (Type I) Display | |
| 61 | Read (Type II) Display | |
| 62 | Read (Type III) Display | |
| 63 | Read (Type IV) Display | |
| 31 | Verify | |

Figure 4-33 Light Pen TAM

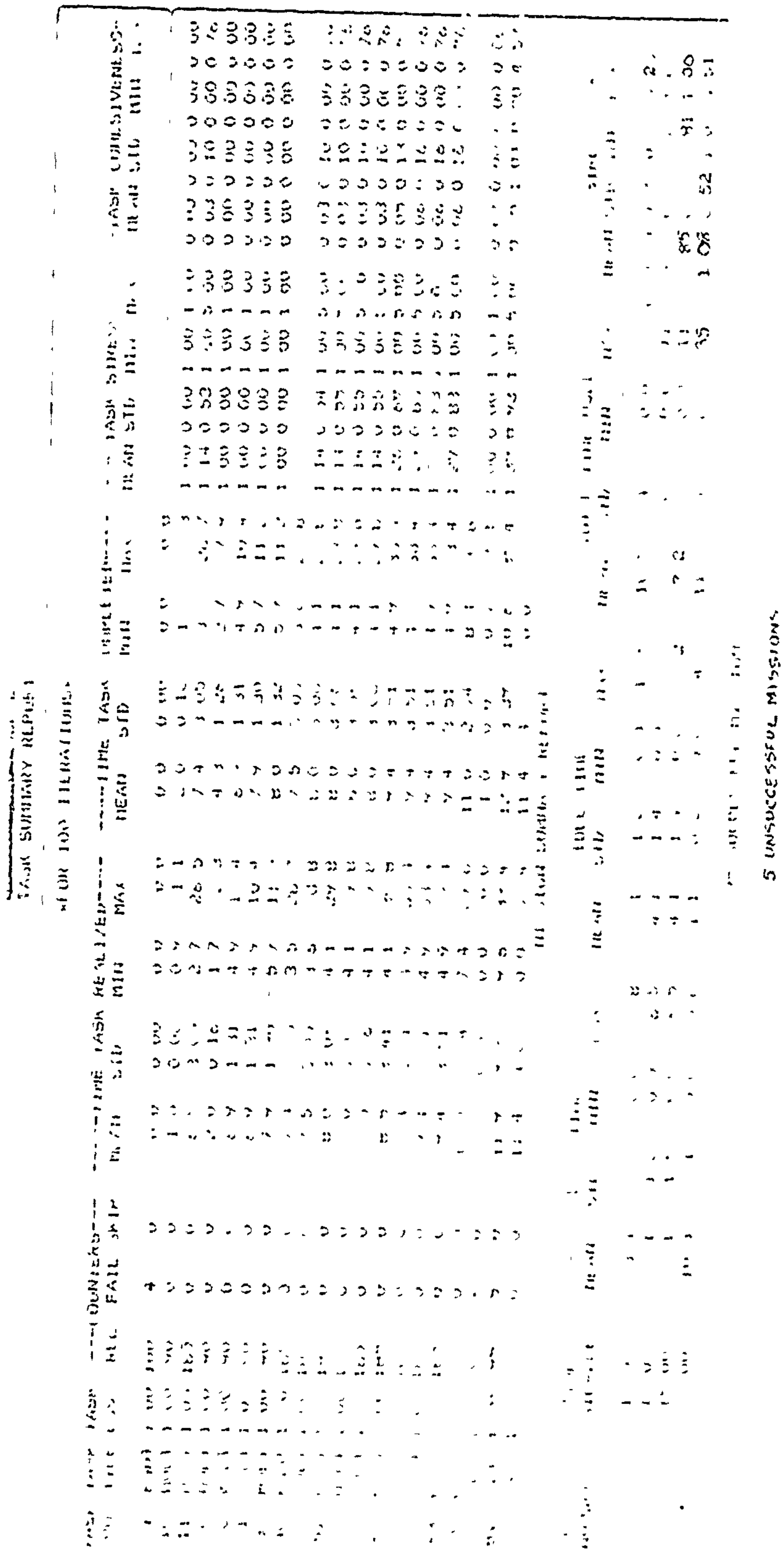


Figure 4-34  Light Pen Report

Table 4-10 presents a summary of the values obtained for the three interface devices:

Table 4-10 Value Summary

| | Keyboard | Push Button | Light Pen |
|---|---|---|---|
| Mean time of completion (seconds) | 14.4 | 10.4 | 11.4 |
| Maximum Average stress | 1.29 | 1.09 | 1.08 |
| Successful missions/100 | 97 | 99 | 95 |
| Time allotted for mission (seconds) | 17.0 | 15.0 | 11.4 |

The least suitable device was the keyboard, although its performance was quite satisfactory. The stress on the operator was, at most, just under half of the operator stress threshold. The light pen was the most suitable interface method. Its completion time was the most task-efficient of the three devices (see paragraph 3.2.1), and the stress on the operators was lowest.

The light pen's showing was close to that of the push button with respect to time, but had a 5% failure rate as opposed to the push button 1%.

The integration of these devices into the IOS console is described in paragraph 4.1.3.3.1.

4.1.3.3 Dynamic Test and Results. The next phase of the evaluation was the incorporation of the three candidate interface devices into the dynamic model, i.e., RTP. Leg 6 of the RTP was chosen because of the number of times the discrete malfunctions were activated and the mapping displays were called. The time of completion statistics obtained through the running of the two ITD items using the three interfacing techniques were used as parameter sets for those tasks in the RTP. The RTP leg 6 was assigned a time of 2500 seconds for every run. The RTP and the parameter sets were the same ones used for the evaluation of the #1 configuration (paragraph 4.1.2).

4.1.3.3.1 Dynamic Test/Mapping Display. Tasks 1 and 13 in leg 6 of the RTP required the calling up, scaling and centering of a map. The parameter set for the keyboard TAM was inserted into the RTP for tasks 1 and 3. The values of this parameter set, in seconds, 23.1/mean, 3.1/minimum, 36.5/maximum, and 5.17/standard.

The branches from tasks 1 and 13 indicating successful completion of the tasks were assigned a value of 0.97. The branches taken if the task failed were assigned values of 0.03.

The results of running the RTP with the keyboard interface handling the map display tasks are shown in Figure 4-35. There were 77/100 successful missions. Task 1 failed four times and had to be repeated. Task 13 failed once and was repeated. The mean stress values on the operators were:

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD | BUSY TIME MIN | BUSY TIME MAX | IDLE TIME MEAN | IDLE TIME STD | IDLE TIME MIN | IDLE TIME MAX | TOTAL TIME USED MEAN | TOTAL TIME USED STD | TOTAL TIME USED MIN | TOTAL TIME USED MAX | STRESS MEAN | STRESS STD | STRESS MIN | STRESS MAX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2500 00 | 1887 1 | 136 8 | 1746 0 | 2409 9 | 620 8 | 23.5 | 580.6 | 685 8 | 2507 9 | 155 6 | 2363 4 | 3071.3 | 2.22 | 0 19 | 1 99 | 2 81 |
| 2 | 2500 00 | 1839 3 | 158 0 | 1664 6 | 2387 9 | 668.6 | 28 0 | 609 9 | 724 6 | 2507 9 | 155 6 | 2363 4 | 3071.3 | 2 11 | 0.20 | 1 85 | 2 72 |
| 3 | 2500 00 | 1839 3 | 158 0 | 1664 6 | 2387 9 | 668 6 | 28.0 | 609 9 | 724 6 | 2507 9 | 155 6 | 2363 4 | 3071 3 | 2 11 | 0.20 | 1 85 | 2 72 |
| 4 | 2500 00 | 2011 9 | 155 3 | 1856 7 | 2586 8 | 496 1 | 13 6 | 459 7 | 534 4 | 2507 9 | 155 6 | 2363 4 | 3071 3 | 2 22 | 0 19 | 1 97 | 2 80 |
| 5 | 2500 00 | 1671 3 | 10 7 | 1654 1 | 1703 3 | 815 0 | 142 6 | 677 9 | 1356 3 | 2486 3 | 142 7 | 2349 5 | 3022.8 | 2 44 | 0 10 | 2 33 | 2 78 |
| 6 | 2500 00 | 316 5 | 3 5 | 309 7 | 339 5 | 2169 8 | 142 7 | 2031.5 | 2710.5 | 2486 3 | 142 7 | 2349 5 | 3022.8 | 1 79 | 0 08 | 1.71 | 2 02 |
| 7 | 2500 00 | 316 5 | 3 5 | 309 7 | 339 5 | 2169 8 | 142 7 | 2031 5 | 2710 5 | 2486 3 | 142 7 | 2349 5 | 3022 8 | 1.79 | 0.08 | 1 71 | 2 02 |

77 SUCCESSFUL MISSIONS

23 UNSUCCESSFUL MISSIONS

Figure 4-35 Keyboard Report (1 of 3)

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK | TASK | TASK | ---COUNTERS--- | | | ----TIME TASK REALIZED---- | | | | ----TIME TASK COMPLETED--- | | | | ----TASK STRESS---- | | | | -TASK COHESIVENESS- | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NO | TYPE | LSS | REL | FAIL | SKIP | MEAN | STD | MIN | MAX | MEAN | STD | MIN | MAX | MEAN | STD | MIN | MAX | MEAN | STD | MIN | MAX |
| 1 | MULT | 1.00 | 104 | 4 | 0 | 112.1 | 8.66 | 96.0 | 137.0 | 134.0 | 9.97 | 110.0 | 163.2 | 1.02 | 0.00 | 1.01 | 1.03 | 0.01 | 0.00 | 0.00 | 0.01 |
| 2 | MULT | 1.00 | 102 | 2 | 0 | 223.3 | 9.83 | 198.4 | 250.0 | 249.1 | 10.71 | 224.6 | 281.0 | 1.04 | 0.01 | 1.02 | 1.05 | 0.01 | 0.00 | 0.01 | 0.01 |
| 3 | MULT | 1.00 | 101 | 1 | 0 | 249.1 | 10.80 | 224.6 | 281.0 | 249.1 | 10.80 | 224.6 | 281.0 | 1.04 | 0.01 | 1.02 | 1.05 | 0.01 | 0.00 | 0.01 | 0.01 |
| 4 | MULT | 1.00 | 100 | 0 | 0 | 333.3 | 9.74 | 311.7 | 363.7 | 333.3 | 9.74 | 311.7 | 363.7 | 1.08 | 0.01 | 1.06 | 1.10 | 0.02 | 0.00 | 0.02 | 0.03 |
| 5 | MULT | 1.00 | 129 | 29 | 0 | 467.1 | 12.04 | 443.6 | 518.4 | 482.1 | 13.41 | 451.6 | 536.6 | 1.10 | 0.01 | 1.08 | 1.12 | 0.03 | 0.00 | 0.02 | 0.03 |
| 6 | MULT | 1.00 | 100 | 0 | 0 | 525.5 | 15.60 | 493.8 | 575.0 | 534.0 | 15.62 | 503.6 | 585.7 | 1.12 | 0.01 | 1.09 | 1.18 | 0.03 | 0.00 | 0.02 | 0.05 |
| 7 | MULT | 1.00 | 122 | 22 | 0 | 635.4 | 15.62 | 605.6 | 681.1 | 648.5 | 15.48 | 616.1 | 688.3 | 1.14 | 0.02 | 1.11 | 1.21 | 0.04 | 0.01 | 0.03 | 0.06 |
| 8 | MULT | 1.00 | 101 | 1 | 0 | 648.9 | 15.49 | 616.1 | 688.3 | 655.3 | 15.50 | 621.8 | 694.4 | 1.14 | 0.02 | 1.11 | 1.21 | 0.04 | 0.01 | 0.03 | 0.06 |
| 9 | MULT | 1.00 | 127 | 27 | 0 | 728.7 | 14.70 | 697.4 | 773.1 | 740.2 | 15.14 | 704.7 | 789.6 | 1.21 | 0.02 | 1.17 | 1.27 | 0.06 | 0.01 | 0.05 | 0.08 |
| 10 | MULT | 1.00 | 101 | 1 | 0 | 740.7 | 15.65 | 704.7 | 789.6 | 746.3 | 15.54 | 710.4 | 795.9 | 1.21 | 0.02 | 1.17 | 1.27 | 0.06 | 0.01 | 0.05 | 0.08 |
| 11 | MULT | 1.00 | 108 | 8 | 0 | 1247.1 | 26.83 | 1189.4 | 1338.1 | 1256.2 | 26.35 | 1199.4 | 1345.1 | 2.00 | 0.00 | 2.00 | 2.00 | 0.59 | 0.23 | 0.29 | 0.76 |
| 12 | MULT | 1.00 | 114 | 14 | 0 | 1285.3 | 25.02 | 1224.5 | 1375.2 | 1294.5 | 25.34 | 1234.6 | 1388.6 | 2.00 | 0.00 | 2.00 | 2.00 | 0.51 | 0.24 | 0.29 | 0.76 |
| 13 | MULT | 1.00 | 101 | 1 | 0 | 1752.6 | 26.55 | 1691.8 | 1844.4 | 1765.1 | 27.01 | 169[illegible].0 | 1854.3 | 2.00 | 0.00 | 2.00 | 2.00 | 0.29 | 0.00 | 0.29 | 0.29 |
| 14 | MULT | 1.00 | 124 | 24 | 0 | 2432.6 | 115.56 | 2287.3 | 2837.5 | 2450.9 | 132.08 | 2299.7 | 2886.3 | 2.96 | 1.33 | 2.00 | 5.00 | 1.36 | 1.26 | 0.33 | 4.24 |
| 15 | MULT | 1.00 | 100 | 0 | 0 | 2486.3 | 142.74 | 2349.5 | 3022.8 | 2507.9 | 155.57 | 2363.4 | 3071.3 | 2.65 | 1.22 | 2.00 | 5.00 | 1.32 | 1.70 | 0.29 | 4.57 |
| 20 | MULT | 1.00 | 100 | 0 | 0 | 2419.8 | 112.81 | 2299.7 | 2886.3 | 2419.8 | 112.81 | 2299.7 | 2886.3 | 2.94 | 0.95 | 2.50 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 21 | SING | 1.00 | 100 | 0 | 0 | 2419.8 | 112.81 | 2299.7 | 2886.3 | 2419.8 | 112.81 | 2299.7 | 2886.3 | 2.54 | 1.13 | 2.00 | 5.00 | 1.02 | 1.59 | 0.29 | 4.57 |
| 22 | SING | 1.00 | 100 | 0 | 0 | 2419.8 | 112.81 | 2299.7 | 2886.3 | 2445.3 | 127.67 | 2317.4 | 2950.6 | 2.54 | 1.13 | 2.00 | 5.00 | 1.02 | 1.59 | 0.29 | 4.57 |
| 23 | MULT | 1.00 | 100 | 0 | 0 | 2419.8 | 112.81 | 2299.7 | 2886.3 | 2470.4 | 142.58 | 2332.8 | 3007.1 | 2.60 | 1.15 | 2.00 | 5.00 | 1.07 | 1.62 | 0.29 | 4.57 |
| 24 | SING | 1.00 | 100 | 0 | 0 | 2419.8 | 112.81 | 2299.7 | 2886.3 | 2470.4 | 142.45 | 2333.2 | 3006.3 | 2.60 | 1.15 | 2.00 | 5.00 | 1.07 | 1.62 | 0.29 | 4.57 |
| 25 | MULT | 1.00 | 100 | 0 | 0 | 2470.5 | 142.62 | 2333.2 | 3007.1 | 2470.5 | 142.62 | 2333.2 | 3007.1 | 3.03 | 1.02 | 2.50 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 26 | MULT | 1.00 | 100 | 0 | 0 | 903.0 | 26.78 | 845.4 | 994.6 | 903.0 | 26.78 | 845.4 | 994.6 | 1.74 | 0.14 | 1.49 | 2.35 | 0.00 | 0.00 | 0.00 | 0.00 |
| 27 | SING | 1.00 | 100 | 0 | 0 | 903.0 | 26.78 | 845.4 | 994.6 | 920.9 | 25.92 | 865.5 | 1011.7 | 1.50 | 0.10 | 1.32 | 1.90 | 0.14 | 0.03 | 0.09 | 0.26 |
| 28 | SING | 1.00 | 100 | 0 | 0 | 903.0 | 26.78 | 845.4 | 994.6 | 935.3 | 26.90 | 879.6 | 1029.2 | 1.74 | 0.14 | 1.49 | 2.35 | 0.14 | 0.03 | 0.09 | 0.26 |
| 29 | SING | 1.00 | 100 | 0 | 0 | 920.9 | 25.92 | 865.5 | 1011.7 | 920.9 | 25.92 | 865.5 | 1011.7 | 1.50 | 0.10 | 1.32 | 1.90 | 0.14 | 0.03 | 0.09 | 0.26 |
| 30 | SING | 1.00 | 100 | 0 | 0 | 920.9 | 25.92 | 865.5 | 1011.7 | 938.6 | 25.09 | 885.4 | 1028.2 | 1.50 | 0.10 | 1.32 | 1.90 | 0.14 | 0.03 | 0.09 | 0.26 |
| 31 | MULT | 1.00 | 100 | 0 | 0 | 903.0 | 26.78 | 845.4 | 994.6 | 937.4 | 25.28 | 883.9 | 1027.4 | 1.50 | 0.10 | 1.32 | 1.90 | 0.14 | 0.03 | 0.09 | 0.26 |
| 32 | SING | 1.00 | 100 | 0 | 0 | 903.0 | 26.78 | 845.4 | 994.6 | 937.4 | 25.27 | 884.3 | 1027.0 | 1.50 | 0.10 | 1.32 | 1.90 | 0.14 | 0.03 | 0.09 | 0.26 |
| 33 | MULT | 1.00 | 100 | 0 | 0 | 938.6 | 25.18 | 885.4 | 1029.2 | 938.6 | 25.18 | 885.4 | 1029.2 | 1.75 | 0.15 | 1.48 | 2.45 | 0.00 | 0.00 | 0.00 | 0.00 |
| 34 | MULT | 1.00 | 300 | 0 | 0 | 1156.6 | 626.70 | 388.8 | 2030.7 | 1156.6 | 626.70 | 388.8 | 2030.7 | 2.94 | 1.59 | 1.12 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 35 | SING | 1.00 | 300 | 0 | 0 | 1156.6 | 626.70 | 388.8 | 2030.7 | 1252.9 | 655.56 | 438.5 | 2150.8 | 3.21 | 1.59 | 1.12 | 5.00 | 1.86 | 1.90 | 0.02 | 4.57 |
| 36 | SING | 1.00 | 300 | 0 | 0 | 1156.6 | 626.70 | 388.8 | 2030.7 | 1185.9 | 641.81 | 416.6 | 2096.0 | 3.22 | 1.62 | 1.08 | 5.00 | 1.86 | 1.88 | 0.02 | 4.57 |
| 37 | SING | 1.00 | 300 | 0 | 0 | 1185.9 | 641.81 | 416.6 | 2096.0 | 1206.7 | 640.37 | 416.6 | 2096.0 | 3.30 | 1.64 | 1.08 | 5.00 | 1.88 | 1.83 | 0.02 | 4.57 |
| 38 | MULT | 1.00 | 300 | 0 | 0 | 1156.6 | 626.70 | 388.8 | 2030.7 | 1252.3 | 652.18 | 441.7 | 2148.5 | 3.18 | 1.61 | 1.08 | 5.00 | 1.80 | 1.84 | 0.02 | 4.57 |
| 39 | SING | 1.00 | 300 | 0 | 0 | 1206.7 | 640.37 | 416.6 | 2096.0 | 1256.8 | 654.32 | 443.6 | 2153.3 | 3.30 | 1.64 | 1.08 | 5.00 | 1.94 | 1.92 | 0.02 | 4.57 |
| 40 | SING | 1.00 | 300 | 0 | 0 | 1156.6 | 626.70 | 388.8 | 2030.7 | 1253.9 | 654.02 | 443.0 | 2150.2 | 3.26 | 1.63 | 1.08 | 5.00 | 1.88 | 1.90 | 0.02 | 4.57 |
| 41 | MULT | 1.00 | 300 | 0 | 0 | 1257.6 | 654.91 | 443.6 | 2153.3 | 1257.6 | 654.91 | 443.6 | 2153.3 | 2.85 | 1.44 | 1.12 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 42 | MULT | 1.00 | 200 | 0 | 0 | 1125.0 | 471.33 | 621.8 | 1687.0 | 1125.0 | 471.33 | 621.8 | 1687.0 | 1.88 | 0.62 | 1.20 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 43 | SING | 1.00 | 200 | 0 | 0 | 1125.0 | 471.33 | 621.8 | 1687.0 | 1146.1 | 468.35 | 648.0 | 1705.3 | 1.71 | 0.54 | 1.13 | 2.39 | 0.23 | 0.18 | 0.04 | 0.47 |
| 44 | SING | 1.00 | 200 | 0 | 0 | 1125.0 | 471.33 | 621.8 | 1687.0 | 1205.8 | 510.57 | 667.0 | 1806.9 | 2.38 | 1.12 | 1.20 | 3.50 | 0.53 | 0.48 | 0.04 | 1.00 |
| 45 | MULT | 1.00 | 200 | 0 | 0 | 1125.0 | 471.33 | 621.8 | 1687.0 | 1165.5 | 465.40 | 671.2 | 1722.2 | 1.68 | 0.51 | 1.13 | 2.33 | 0.21 | 0.16 | 0.04 | 0.44 |
| 46 | SING | 1.00 | 200 | 0 | 0 | 1146.1 | 468.35 | 648.0 | 1705.3 | 1186.7 | 462.51 | 697.4 | 1740.3 | 1.71 | 0.53 | 1.13 | 2.38 | 0.22 | 0.18 | 0.04 | 0.47 |
| 47 | SING | 1.00 | 200 | 0 | 0 | 1125.0 | 471.33 | 621.8 | 1687.0 | 1165.6 | 465.55 | 670.9 | 1721.6 | 1.74 | 0.56 | 1.13 | 2.44 | 0.24 | 0.19 | 0.04 | 0.50 |
| 48 | MULT | 1.00 | 200 | 0 | 0 | 1220.2 | 496.08 | 697.4 | 1806.9 | 1220.2 | 496.08 | 697.4 | 1806.9 | 1.91 | 0.59 | 1.25 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 49 | MULT | 1.00 | 200 | 0 | 0 | 938.7 | 357.54 | 553.2 | 1388.6 | 938.7 | 357.54 | 553.2 | 1388.6 | 1.88 | 0.71 | 1.16 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 50 | SING | 1.00 | 200 | 0 | 0 | 938.7 | 357.54 | 553.2 | 1388.6 | 947.4 | 366.24 | 553.2 | 1405.7 | 1.58 | 0.44 | 1.11 | 2.10 | 0.17 | 0.14 | 0.03 | 0.76 |
| 51 | SING | 1.00 | 200 | 0 | 0 | 938.7 | 357.54 | 553.2 | 1388.6 | 1020.8 | 395.47 | 600.1 | 1508.7 | 2.37 | 1.17 | .16 | 5.00 | 0.56 | 0.63 | 0.03 | 4.57 |
| 52 | SING | 1.00 | 200 | 0 | 0 | 947.4 | 366.24 | 553.2 | 1405.7 | 968.6 | 362.37 | 579.4 | 1423.1 | 1.59 | 0.44 | 1.11 | 2.12 | 0.19 | 0.14 | 0.03 | 0.76 |
| 53 | MULT | 1.00 | 200 | 0 | 0 | 938.7 | 357.54 | 553.2 | 1388.6 | 979.6 | 349.91 | 604.1 | 1422.2 | 1.57 | 0.43 | 1.11 | 2.05 | 0.17 | 0.14 | 0.03 | 0.76 |
| 54 | SING | 1.00 | 200 | 0 | 0 | 968.6 | 362.37 | 579.4 | 1423.1 | 989.8 | 358.47 | 606.6 | 1439.3 | 1.58 | 0.44 | 1.11 | 2.11 | 0.17 | 0.14 | 0.03 | 0.76 |
| 55 | SING | 1.00 | 200 | 0 | 0 | 938.7 | 357.54 | 553.2 | 1388.6 | 979.8 | 350.09 | 604.1 | 1422.7 | 1.60 | 0.45 | 1.11 | 2.14 | 0.18 | 0.15 | 0.03 | 0.76 |
| 56 | MULT | 1.00 | 200 | 0 | 0 | 1023.8 | 392.45 | 606.6 | 1508.7 | 1023.8 | 392.45 | 606.6 | 1508.7 | 1.86 | 0.64 | 1.17 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 57 | MULT | 1.00 | 500 | 0 | 0 | 981.8 | 682.60 | 110.0 | 2153.3 | 981.8 | 682.60 | 110.0 | 2153.3 | 2.32 | 1.00 | 1.03 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 58 | SING | 1.00 | 500 | 0 | 0 | 981.8 | 682.80 | 110.0 | 2153.3 | 1018.3 | 694.33 | 138.1 | 2214.5 | 2.60 | 1.28 | 1.02 | 5.00 | 0.85 | 1.01 | 0.01 | 4.42 |

Figure 4-35 Keyboard Report (2 of 3)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [illegible] | SING | 1 | [illegible] | 500 | 0 | 0 | 1018 | 3 | 694 | 33 | 138 | 1 | 2214 | 5 | 1021 | 6 | 692 | 11 | 138 | 1 | 2214 | 5 | 2 | 67 | 1 | 35 | 1 | 02 | 5 | 00 | 0 | 95 | 1 | 17 | 0 | 01 | 4 | 57 |
| [illegible] | SING | 1 | [illegible] | [illegible] | 0 | 0 | 1021 | 6 | 692 | 11 | 138 | 1 | 2214 | 5 | 1034 | 1 | 712 | 25 | 138 | 1 | 2279 | 7 | 2 | 67 | 1 | 34 | 1 | 02 | 5 | 00 | 0 | 95 | 1 | 17 | 0 | 01 | 4 | 57 |
| [illegible] | SING | 1 | [illegible] | [illegible] | 0 | 0 | 981 | 8 | 682 | 80 | 110 | 0 | 2153 | 3 | 1108 | 3 | 727 | 33 | 196 | 3 | 2330 | 6 | 2 | 64 | 1 | 02 | 1 | 03 | 4 | 37 | 0 | 77 | 0 | 67 | 0 | 01 | 3 | 02 |
| [illegible] | SING | 1 | [illegible] | [illegible] | 0 | 0 | 1034 | 1 | 712 | 25 | 138 | 1 | 2279 | 7 | 1049 | 5 | 702 | 14 | 168 | 5 | 2279 | 7 | 2 | 68 | 1 | 35 | 1 | 02 | 5 | 00 | 1 | 03 | 1 | 31 | 0 | 01 | 4 | 57 |
| | SING | [illegible] | [illegible] | [illegible] | 0 | 0 | 1049 | 5 | 702 | 14 | 168 | 5 | 2279 | 7 | 1055 | 3 | 695 | 03 | 199 | 4 | 2279 | 7 | 2 | 69 | 1 | 37 | 1 | 02 | 5 | 00 | 1 | 03 | 1 | 30 | 0 | 01 | 4 | 57 |
| [illegible] | MULT | 1 | [illegible] | 500 | 0 | 0 | 981 | 0 | 682 | 80 | 110 | 0 | 2153 | 3 | 1080 | 7 | 714 | 29 | 196 | 8 | 2333 | 1 | 2 | 54 | 1 | 23 | 1 | 02 | 5 | 00 | 0 | 81 | 0 | 97 | 0 | 01 | 4 | 25 |
| [illegible] | SING | 1 | 00 | 500 | 0 | 0 | 981 | 8 | 682 | 80 | 110 | 0 | 2153 | 3 | 1089 | 7 | 717 | 40 | 197 | 3 | 2333 | 7 | 2 | 64 | 1 | 30 | 1 | 02 | 5 | 00 | 0 | 86 | 1 | 00 | 0 | 01 | 4 | 42 |
| [illegible] | MULT | 1 | 00 | 500 | 0 | 0 | 1109 | 7 | 726 | 59 | 198 | 4 | 2333 | 7 | 1109 | 7 | 726 | 59 | 198 | 4 | 2333 | 7 | 2 | 66 | 1 | 38 | 1 | 03 | 5. | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| [illegible] | MULT | 1 | 00 | 100 | 0 | 0 | 0 | 0 | 0 | 00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 00 | 0 | 0 | 0 | 0 | 1 | 00 | 0 | 00 | 1 | 00 | 1 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| [illegible] | MULT | 1 | 00 | 103 | 3 | 0 | 0 | 0 | 0 | 00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 00 | 0 | 0 | 0 | 0 | 1 | 00 | 0 | 00 | 1 | 00 | 1 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| [illegible] | MULT | 1 | [illegible] | 100 | 0 | 0 | 0 | 0 | 0 | 00 | 0 | 0 | 0 | 0 | 30 | 9 | 1 | 00 | 28. | 6 | 32 | 6 | 1 | 00 | 0 | 00 | 1 | 00 | 1 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| [illegible] | MULT | 1 | [illegible] | 101 | 4 | 0 | 31 | 3 | 2 | 26 | 28 | 6 | 46 | 4 | 43 | 3 | 6 | 85 | 29 | 4 | 61 | 2 | 1 | 00 | 0 | 00 | 1 | 00 | 1 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| [illegible] | MULT | 1 | 00 | 100 | 0 | 0 | 43 | 4 | 6 | 91 | 29 | 4 | 61 | 2 | 53 | 6 | 8 | 10 | 37 | 2 | 76 | 2 | 1 | 00 | 0 | 00 | 1 | 00 | 1 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| [illegible] | MULT | 1 | 00 | 100 | 0 | 0 | 53 | 6 | 8 | 10 | 37 | 2 | 76 | 2 | 111 | 0 | 7 | 49 | 96 | 0 | 131 | 7 | 1 | 03 | 0 | 01 | 1 | 02 | 1 | 05 | 0 | 01 | 0 | 00 | 0 | 00 | 0 | 01 |
| 83 | MULT | 1 | 00 | 100 | 0 | 0 | 53 | 6 | 8 | 10 | 37 | 2 | 76 | 2 | 63 | 3 | 8 | 35 | 41 | 9 | 82 | 2 | 1 | 02 | 0 | 00 | 1 | 01 | 1 | 03 | 0 | 01 | 0 | 00 | 0 | 00 | 0 | 01 |
| 84 | MULT | 1 | 00 | 102 | 2 | 0 | 63 | 4 | 8 | 31 | 41 | 9 | 82 | 2 | 75 | 0 | 9 | 96 | 48 | 5 | 97 | 3 | 1 | 02 | 0 | 00 | 1 | 01 | 1 | 03 | 0 | 01 | 0 | 00 | 0 | 00 | 0 | 01 |
| 85 | MULT | 1 | 00 | 100 | 0 | 0 | 75 | 1 | 10 | 00 | 48 | 5 | 97 | 3 | 84 | 8 | 10 | 48 | 56 | 8 | 112 | 8 | 1 | 02 | 0 | 00 | 1 | 01 | 1 | 03 | 0 | 01 | 0 | 00 | 0 | 00 | 0 | 01 |
| 86 | MULT | 1 | 00 | 100 | 0 | 0 | 84 | 8 | 10 | 48 | 56 | 8 | 112 | 8 | 96 | 2 | 12 | 32 | 58 | 5 | •25 | 2 | 1 | 02 | 0 | 00 | 1 | 01 | 1 | 03 | 0 | 01 | 0 | 00 | 0 | 00 | 0 | 01 |
| 88 | MULT | 1 | 00 | 100 | 0 | 0 | 111 | 3 | 7 | 71 | 96 | 0 | 131 | 7 | 111 | 3 | 7 | 71 | 96 | 0 | 131 | 7 | 1 | 03 | 0 | 01 | 1 | 01 | 1 | 05 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| 89 | MULT | 1 | 00 | 200 | 0 | 0 | 2092 | 6 | 392 | 47 | 1654 | 9 | 3007 | 1 | 2092 | 6 | 392 | 47 | 1654 | 9 | 3007 | 1 | 3 | 54 | 1 | 14 | 2 | 50 | 5 | 00 | 0 | 00 | 0 | 00 | 0. | 00 | 0 | 00 |
| 90 | MULT | 1 | 00 | 200 | 0 | 0 | 2092 | 6 | 392 | 47 | 1654 | 9 | 3007 | 1 | 2109 | 2 | 376 | 41 | 1687 | 9 | 3007 | 1 | 3 | 44 | 1 | 46 | 2 | 00 | 5 | 00 | 1 | 56 | 1 | 55 | 0 | 29 | 4 | 57 |
| 91 | MULT | 1 | 00 | 200 | 0 | 0 | 2109 | 2 | 376 | 41 | 1687 | 9 | 3007 | 1 | 2119 | 3 | 381 | 93 | 1691 | 8 | 3022 | 8 | 3. | 38 | 1. | 42 | 2 | 00 | 5 | 00 | 1 | 51 | 1 | 54 | 0 | 29 | 4 | 57 |
| 92 | MULT | 1 | 00 | 200 | 0 | 0 | 2119 | 3 | 381 | 93 | 1691 | 8 | 3022 | 8 | 2119 | 3 | 381 | 93 | 1691 | 8 | 3022 | 8 | 3 | 43 | 1 | 45 | 2 | 00 | 5 | 00 | 1 | 56 | 1 | 55 | 0 | 29 | 4 | 57 |
| 93 | MULT | 1 | 00 | 200 | 0 | 0 | 2119 | 3 | 381 | 93 | 1691 | 8 | 3022 | 8 | 2119 | 3 | 381 | 93 | 1691 | 8 | 3022 | 8 | 3 | 43 | 1 | 45 | 2 | 00 | 5 | 00 | 1 | 56 | 1 | 55 | 0. | 29 | 4 | 57 |
| 94 | MULT | 1 | 00 | 200 | 0 | 0 | 2119 | 3 | 381 | 93 | 1691 | 8 | 3022 | 8 | 2119 | 3 | 381 | 93 | 1691 | 8 | 3022 | 8 | 3 | 54 | 1 | 15 | 2 | 50 | 5 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| 95 | MULT | 1 | 00 | 400 | 0 | 0 | 821 | 5 | 607 | 24 | 224 | 6 | 1854 | 3 | •821 | 5 | 607 | 24 | 224 | 6 | 1854 | 3 | 2 | 06 | 1 | 01 | 1 | 05 | 4 | 90 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| 96 | MULT | 1 | 00 | 400 | 0 | 0 | 821 | 5 | 607 | 24 | 224 | 6 | 1854 | 3 | 864 | 1 | 619 | 18 | 255 | 0 | 1913 | 2 | 2 | 28 | 1 | 22 | 1 | 04 | 4 | 83 | 0 | 64 | 0 | 70 | 0. | 01 | 3. | 38 |
| 97 | MULT | 1 | 00 | 400 | 0 | 0 | 864 | 1 | 619 | 18 | 255 | 0 | 1913 | 2 | 908 | 0 | 632 | 84 | 283. | 6 | 1976 | 2 | 2 | 45 | 1 | 42 | 1 | 04 | 5 | 00 | 0 | 75 | 0 | 86 | 0 | 01 | 4. | 47 |
| 98 | SING | 1 | 00 | 400 | 0 | 0 | 864 | 1 | 619 | 18 | 255 | 0 | 1913 | 2 | 947 | 8 | 651 | 24 | 307 | 7 | 2030 | 7 | 2 | 70 | 1 | 63 | 1 | 09 | 5 | 00 | 0 | 91 | 1 | 08 | 0 | 02 | 4 | 57 |
| 99 | MULT | 1 | 00 | 400 | 0 | 0 | 864 | 1 | 619 | 18 | 255 | 0 | 1913 | 2 | 928 | 9 | 644 | 47 | 311 | 7 | 2029 | 0 | 1 | 93 | 0 | 95 | 1 | 04 | 3 | 50 | 0 | 39 | 0 | 41 | 0 | 01 | 1 | 24 |
| 100 | MULT | 1 | 00 | 400 | 0 | 0 | 908 | 0 | 632 | 84 | 283 | 6 | 1976 | 2 | 908 | 0 | 632 | 84 | 283. | 6 | 1976. | 2 | 2 | 66 | 1 | 63 | 1 | 06 | 5 | 00 | 1 | 10 | 1 | 41 | 0 | 02 | 4 | 57 |
| 101 | MULT | 1 | 00 | 400 | 0 | 0 | 908 | 0 | 632 | 84 | 283 | 6 | 1976 | 2 | 908 | 0 | 632 | 84 | 283 | 6 | 1976 | 2 | 2 | 66 | 1 | 63 | 1 | 06 | 5 | 00 | 1 | 10 | 1 | 41 | 0 | 02 | 4 | 57 |
| 102 | MULT | 1 | 00 | 400 | 0 | 0 | 950 | 8 | 649 | 44 | 311 | 7 | 2030 | 7 | 950 | 8 | 649 | 44 | 311 | 7 | 2030 | 7 | 2 | 53 | 1 | 58 | 1 | 09 | 5 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| 117 | MULT | 1 | 00 | 400 | 0 | 0 | 1182 | 5 | 674 | 97 | 451 | 6 | 2333 | 7 | 1182 | 5 | 674 | 97 | 451 | 6 | 2333 | 7 | 2 | 91 | 1 | 64 | 1 | 13 | 5 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| 118 | MULT | 1 | 00 | 607 | 207 | 0 | 1464 | 8 | 774 | 46 | 451. | 6 | 2599 | 0 | 1484 | 2 | 786 | 44 | 467 | 9 | 2633 | 6 | 3 | 12 | 1 | 69 | 1 | 09 | 5 | 00 | 1 | 55 | 1 | 47 | 0 | 02 | 4 | 57 |
| 119 | MULT | 1 | 00 | 400 | 0 | 0 | 1211 | 9 | 707 | 33 | 467 | 9 | 2633 | 6 | 1242 | 4 | 723 | 09 | 493 | 8 | 2698 | 8 | 2 | 50 | 1 | 49 | 1 | 09 | 5 | 00 | 1 | 34 | 1 | 85 | 0 | 02 | 4 | 57 |
| 120 | MULT | 1 | 00 | 490 | 90 | 0 | 1449 | 7 | 791 | 11 | 493 | 8 | 2698 | 8 | 1449 | 7 | 791 | 11 | 493 | 8 | 2698 | 8 | 2 | 94 | 1 | 66 | 1 | 09 | 5 | 00 | 1 | 41 | 1 | 46 | 0 | 02 | 4 | 57 |
| 121 | MULT | 1 | 00 | 400 | 0 | 0 | 1242 | 4 | 723 | 09 | 493 | 8 | 2698 | 8 | 1242 | 4 | 723 | 09 | 493. | 8 | 2698 | 8 | 2 | 49 | 1 | [illegible] | 1 | 09 | 5 | 00 | 1 | 36 | 1 | 87 | 0 | 02 | 4 | 57 |
| 122 | MULT | 1 | 00 | 400 | 0 | 0 | 1242 | 4 | 723 | 09 | 493 | 8 | 2698 | 8 | 1242 | 4 | 723 | 09 | 493. | 8 | 2698 | 8 | 2 | 49 | 1 | [illegible] | 1 | 09 | 5 | 00 | 1 | 02 | 1 | 31 | 0 | 02 | 4 | 57 |

Figure 4-35 Keyboard Report (3 of 3)

4.1.3.3.1 Dynamic Test/Mapping Display (Cont'd)

Operator 1 - 2.22
Operator 2 - 2.11
Operator 3 - 2.11
Operator 4 - 2.22
Operator 5 - 2.44
Operator 6 - 1.79
Operator 7 - 1.79

The times of completion, in seconds, were 2507.9/mean, 2363.4/minimum, 3071.3/maximum, and 155.57/standard.

The parameter sets for tasks 1 and 13 were then changed to those parameters obtained from performing mapping display tasks via push buttons. The probability of successful completions of these tasks was set at 0.99 and that of failure at 0.01. The results of this RTP (Figure 4-36) were 80/100 successful missions. Task 1 failed only once, while task 13 has no failures. The mean stresses on the operators were:

Operator 1 - 2.19
Operator 2 - 2.08
Operator 3 - 2.08
Operator 4 - 2.18
Operator 5 - 2.43
Operator 6 - 1.73
Operator 7 - 1.78

The times of completion, in seconds, were 2493.8/mean, 2318.4/minimum, 3061.8/maximum, and 154.39/standard.

The parameter sets of tasks 1 and 13 were again changed, this time to those parameters obtained from the light pen TAM. The probability of successfully completing tasks 1 and 13 was set at 0.95 and that of failure at 0.05. The rest of the RTP remained unchanged.

The results of the pen parameters in the RTP were 71/100 successful missions (Figure 4-37). Task 1 failed three times and task 13 failed once. The mean stress values on the operators were:

Operator 1 - 2.25
Operator 2 - 2.15
Operator 3 - 2.15
Operator 4 - 2.25
Operator 5 - 2.48
Operator 6 - 1.80
Operator 7 - 1.80

The time for mission completion, in seconds, was 2528.9/mean, 2355.3/minimum, 3112.0/maximum, and 167.78/standard.

A summary of these results is shown in Table 4-11.

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK NO | TASK TYPE | TASK ESS | --COUNTERS--- REL | FAIL | SKIP | ---- TIME TASK REALIZED---- MEAN | STD | MIN | MAX | ----TIME TASK COMPLETED---- MEAN | STD | MIN | MAX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MULT | 1 00 | 101 | 1 | 0 | 111 3 | 7 82 | 96 0 | 131 7 | 126 3 | 9 37 | 102 4 | 150 2 |
| 2 | MULT | 1 00 | 102 | 2 | 0 | 216 1 | 9 28 | 191 4 | 244 3 | 241 9 | 10 09 | 217 8 | 269 1 |
| 3 | MULT | 1 00 | 101 | 1 | 0 | 241 9 | 10 18 | 217 8 | 269 1 | 241 9 | 10 18 | 217 8 | 269 1 |
| 4 | MULT | 1 00 | 100 | 0 | 0 | 326 7 | 9 08 | 305 6 | 352 9 | 326 7 | 9 08 | 305 6 | 352 9 |
| 5 | MULT | 1 00 | 130 | 30 | 0 | 461 7 | 11 64 | 438 5 | 509 4 | 476 8 | 13 13 | 446 2 | 527 9 |
| 6 | MULT | 1 00 | 100 | 0 | 0 | 520 3 | 15 56 | 489 2 | 566 8 | 528 6 | 15 63 | 498 6 | 577 6 |
| 7 | MULT | 1 00 | 123 | 23 | 0 | 630 6 | 15 68 | 602 2 | 673 3 | 644 0 | 15 63 | 611 8 | 683 0 |
| 8 | MULT | 1 00 | 101 | 1 | 0 | 644 4 | 15 75 | 611 8 | 683 0 | 650 8 | 15 72 | 617 6 | 689 9 |
| 9 | MULT | 1 00 | 124 | 24 | 0 | 724 8 | 14 97 | 693 7 | 770 0 | 736 4 | 15 25 | 701 1 | 786 6 |
| 10 | MULT | 1 00 | 100 | 0 | 0 | 736 4 | 15 57 | 701 1 | 786 6 | 742 2 | 15 45 | 706 8 | 792 9 |
| 11 | MULT | 1 00 | 108 | 8 | 0 | 1240 6 | 26 51 | 1183 5 | 1332 6 | 1249 8 | 25 99 | 1194 1 | 1339 6 |
| 12 | MULT | [illegible] | 115 | 15 | 0 | 1278 8 | 24 70 | 1219 2 | 1369 7 | 1288 0 | 25 10 | 1229 3 | 1383 0 |
| 13 | MULT | [illegible] | 100 | 0 | 0 | 1746 0 | 26 41 | 1686 4 | 1838 8 | 1754 7 | 26 87 | 1688 3 | 1844 6 |
| 14 | MULT | 1 00 | 121 | 21 | 0 | 2420 1 | 117 05 | 2262 0 | 2828 0 | 2438 0 | 133 73 | 2262 0 | 2876 8 |
| 15 | MULT | 1 00 | 100 | 0 | 0 | 2473 1 | 142 01 | 2305 5 | 3013 3 | 2473 8 | 154 39 | 2318 4 | 3061 8 |
| 20 | MULT | 1 00 | 100 | 0 | 0 | 2408 2 | 113 16 | 2262 0 | 2876 8 | 2408 2 | 113 16 | 2262 0 | 2876 8 |
| 21 | SING | 1 00 | 100 | 0 | 0 | 2408 2 | 113 16 | 2262 0 | 2876 8 | 2408 2 | 113 16 | 2262 0 | 2876 8 |
| 22 | SING | 1 00 | 100 | 0 | 0 | 2408 2 | 113 16 | 2262 0 | 2876 8 | 2432 7 | 127 26 | 2278 0 | 2941 1 |
| 23 | MULT | 1 00 | 100 | 0 | 0 | 2408 2 | 113 16 | 2262 0 | 2876 8 | 2457 2 | 141 77 | 2295 2 | 2997 6 |
| 24 | SING | 1 00 | 100 | 0 | 0 | 2408 2 | 113 16 | 2262 0 | 2876 8 | 2457 2 | 141 63 | 2295 2 | 2996 8 |
| 25 | MULT | 1 00 | 100 | 0 | 0 | 2457 4 | 141 79 | 2295 2 | 2997 6 | 2457 4 | 141 79 | 2295 2 | 2997 6 |
| 26 | MULT | 1 00 | 100 | 0 | 0 | 896 4 | 26 46 | 839 9 | 989 1 | 896 4 | 26 46 | 839 9 | 989 1 |
| 27 | SING | 1 00 | 100 | 0 | 0 | 896 4 | 26 46 | 839 9 | 989 1 | 914 5 | 25 53 | 860 2 | 1006 1 |
| 28 | SING | 1 00 | 100 | 0 | 0 | 896 4 | 26 46 | 839 9 | 989 1 | 928 7 | 26 41 | 874 5 | 1023 7 |
| 29 | SING | 1 00 | 100 | 0 | 0 | 914 5 | 25 53 | 860 2 | 1006 1 | 914 5 | 25 53 | 860 2 | 1006 1 |
| 30 | SING | 1 00 | 100 | 0 | 0 | 914 5 | [illegible] 53 | 860 2 | 1006 1 | 932 4 | 24 68 | 880 4 | 1022 [illegible] |
| 31 | MULT | 1 00 | 100 | 0 | 0 | 896 4 | 26 46 | 839 9 | 989 1 | 931 2 | 24 87 | 879 0 | 1021 6 |
| 32 | SING | 1 00 | 100 | 0 | 0 | 896 4 | 26 46 | 839 9 | 989 1 | 931 2 | 24 84 | 879 3 | 1021 3 |
| 33 | MULT | 1 00 | 100 | 0 | 0 | 932 4 | 24 75 | 880 4 | 1023 7 | 932 4 | 24 75 | 880 4 | 1023 7 |
| 34 | MULT | 1 00 | 300 | 0 | 0 | 1148 5 | 624 33 | 383 4 | 2019 9 | 1148 5 | 624 33 | 383 4 | 2019 9 |
| 35 | SING | 1 00 | 300 | 0 | 0 | 1148 5 | 624 33 | 383 4 | 2019 9 | 1245 0 | 652 99 | 433 6 | 2140 1 |
| 36 | SING | 1 00 | 300 | 0 | 0 | 1148 5 | 624 33 | 383 4 | 2019 9 | 1177 5 | 638 93 | 411 4 | 2085 2 |
| 37 | SING | 1 00 | 300 | 0 | 0 | 1177 5 | 638 93 | 411 4 | 2085 2 | 1198 4 | 637 55 | 411 4 | 2085 2 |
| 38 | MULT | 1 00 | 300 | 0 | 0 | 1148 5 | 624 33 | 383 4 | 2019 9 | 1243 5 | 648 66 | 436 7 | 2137 7 |
| 39 | SING | 1 00 | 300 | 0 | 0 | 1198 4 | 637 55 | 411 4 | 2085 2 | 1248 5 | 651 42 | 438 5 | 2142 5 |
| 40 | SING | 1 00 | 300 | 0 | 0 | 1148 5 | 624 33 | 383 4 | 2019 9 | 1245 8 | 651 35 | 437 9 | 2139 4 |
| 41 | MULT | 1 00 | 300 | 0 | 0 | 1249 4 | 652 15 | 438 5 | 2142 5 | 1249 4 | 652 15 | 438 5 | 2142 5 |
| 42 | MULT | 1 00 | 200 | 0 | 0 | 1119 6 | 470 45 | 617 6 | 1691 5 | 1119 6 | 470 45 | 617 6 | 1681 5 |
| 43 | SING | 1 00 | 200 | 0 | 0 | 1119 6 | 470 45 | 617 6 | 1681 5 | 1140 9 | 467 35 | 644 0 | 1699 9 |
| 44 | SING | 1 00 | 200 | 0 | 0 | 1119 6 | 470 45 | 617 6 | 1681 5 | 1200 6 | 509 45 | 663 2 | 1801 4 |
| 45 | MULT | 1 00 | 200 | 0 | 0 | 1119 6 | 470 45 | 617 6 | 1681 5 | 1160 3 | 464 28 | 667 4 | 1716 7 |
| 46 | SING | 1 00 | 200 | 0 | 0 | 1140 9 | 467 35 | 644 0 | 1699 9 | 1181 6 | 461 28 | 693 7 | 1734 9 |
| 47 | SING | 1 00 | 200 | 0 | 0 | 1119 6 | 470 45 | 617 6 | 1681 5 | 1160 5 | 464 47 | 667 0 | 1716 2 |
| 48 | MULT | 1 00 | 200 | 0 | 0 | 1215 2 | 494 86 | 693 7 | 1801 4 | 1215 2 | 494 86 | 693 7 | 1801 4 |
| 49 | MULT | 1 00 | 200 | 0 | 0 | 932 8 | 357 08 | 548 4 | 1383 0 | 952 8 | 357 08 | 548 4 | 1383 0 |
| 50 | SING | 1 00 | 200 | 0 | 0 | 932 8 | 357 08 | 548 4 | 1383 0 | 941 4 | 365 75 | 548 4 | 1400 1 |
| 51 | SING | 1 00 | 200 | 0 | 0 | 932 8 | 357 08 | 548 4 | 1383 0 | 1015 1 | 394 74 | 595 9 | 1503 2 |
| 52 | SING | 1 00 | 200 | 0 | 0 | 941 4 | 365 75 | 548 4 | 1400 1 | 962 7 | 361 77 | 574 9 | 1417 5 |
| 53 | MULT | 1 00 | 200 | 0 | 0 | 932 8 | 357 08 | 548 4 | 1383 0 | 973 9 | 349 23 | 599 8 | 1416 5 |
| 54 | SING | 1 00 | 200 | 0 | 0 | 962 7 | 361 77 | 574 9 | 1417 5 | 904 0 | 357 72 | 602 2 | 1433 6 |
| 55 | SING | 1 00 | 200 | 0 | 0 | 932 8 | 357 [illegible] | 548 4 | 1383 0 | 974 0 | 349 36 | 599 7 | 1417 1 |
| 56 | MULT | 1 00 | 200 | 0 | 0 | 1018 1 | 391 78 | 602 [illegible] | [illegible]503 2 | 1018 1 | 391 70 | 602 2 | 1503 2 |
| 57 | MULT | 1 00 | 200 | 0 | 0 | 974 6 | 681 00 | 102 [illegible] | [illegible]142 5 | 974 6 | 681 00 | 102 4 | 2142 5 |

| TASK NO | ----TASK STRESS---- MEAN | STD | MIN | MAX | -TASK COHESIVENESS- MEAN | STD | MIN. | MAX |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 02 | 0 00 | 1 01 | 1 03 | 0.01 | 0.00 | 0 00 | 0 01 |
| 2 | 1 03 | 0 01 | 1 01 | 1 04 | 0 01 | 0 00 | 0 00 | 0 01 |
| 3 | 1 03 | 0 01 | 1 01 | 1 04 | 0 01 | 0 00 | 0 00 | 0 01 |
| 4 | 1 07 | 0 01 | 1 05 | 1 09 | 0 02 | 0 00 | 0 02 | 0.03 |
| 5 | 1 09 | 0 01 | 1 07 | 1 11 | 0 03 | 0 00 | 0 02 | 0.03 |
| 6 | 1 11 | 0 01 | 1 09 | 1 17 | 0 03 | 0 00 | 0 02 | 0 05 |
| 7 | 1 14 | 0 02 | 1 11 | 1 20 | 0 04 | 0.01 | 0 03 | 0 06 |
| 8 | 1 14 | 0 02 | 1 11 | 1 20 | 0 04 | 0 01 | 0 03 | 0 06 |
| 9 | 1 21 | 0 02 | 1 16 | 1 27 | 0 06 | 0 01 | 0 05 | 0 08 |
| 10 | 1 21 | 0 02 | 1 16 | 1 27 | 0 06 | 0 01 | 0.05 | 0 08 |
| 11 | 2 00 | 0 00 | 2 00 | 2 00 | 0.62 | 0 22 | 0 29 | 0 76 |
| 12 | 2 00 | 0 00 | 2 00 | 2 00 | 0 56 | 0 24 | 0 29 | 0.76 |
| 13 | 2 00 | 0 00 | 2 00 | 2 00 | 0 29 | 0 00 | 0 29 | 0 29 |
| 14 | 2 86 | 1 29 | 2 00 | 5 00 | 1 20 | 1 16 | 0 31 | 4 01 |
| 15 | 2 58 | 1 18 | 2 00 | 5 00 | 1 22 | 1 64 | 0 29 | 4 57 |
| 20 | 2 88 | 0 90 | 2 50 | 5 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| 21 | 2 47 | 1 08 | 2 00 | 5 00 | 0 94 | 1 53 | 0 29 | 4 57 |
| 22 | 2 47 | 1 08 | 2 00 | 5 00 | 0 94 | 1 53 | 0 29 | 4 57 |
| 23 | 2 52 | 1 08 | 2 00 | 5 00 | 0 97 | 1 53 | 0 29 | 4 57 |
| 24 | 2 52 | 1 08 | 2 00 | 5 00 | 0 97 | 1 53 | 0 29 | 4 57 |
| 25 | 2 97 | 0 99 | 2 50 | 5 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| 26 | 1 71 | 0 14 | 1 47 | 2 30 | 0 00 | 0 00 | 0 00 | 0 00 |
| 27 | 1 47 | 0 09 | 1 31 | 1 87 | 0 14 | 0 03 | 0 09 | 0 25 |
| 28 | 1 71 | 0 14 | 1 47 | 2 30 | 0 14 | 0 03 | 0 09 | 0 25 |
| 29 | 1 47 | 0 09 | 1 31 | 1 87 | 0 14 | 0 03 | 0 09 | 0 25 |
| 30 | 1 47 | 0 09 | 1 31 | 1 87 | 0 14 | 0 03 | 0 09 | 0 25 |
| 31 | 1 47 | 0 09 | 1 31 | 1 87 | 0 14 | 0 03 | 0 09 | 0 25 |
| 32 | 1 47 | 0.09 | 1 31 | 1 87 | 0 14 | 0 03 | 0 09 | 0 25 |
| 33 | 1 71 | 0 14 | 1 46 | 2 39 | 0 00 | 0 00 | 0 00 | 0 00 |
| 34 | 2 92 | 1 60 | 1 11 | 5 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| 35 | 3 21 | 1 59 | 1 11 | 5 00 | 1 83 | 1 88 | 0 02 | 4 57 |
| 36 | 3 19 | 1 61 | 1 07 | 5 00 | 1 82 | 1 86 | 0 02 | 4 57 |
| 37 | 3 27 | 1 63 | 1 07 | 5 00 | 1 82 | 1 81 | 0 02 | 4 57 |
| 38 | 3 15 | 1 60 | 1 07 | 5 00 | 1 75 | 1 80 | 0 02 | 4 57 |
| 39 | 3 27 | 1 63 | 1 07 | 5 00 | 1 92 | 1 93 | 0 02 | 4 57 |
| 40 | 3 23 | 1 62 | 1 07 | 5 00 | 1 84 | 1 88 | 0 02 | 4 57 |
| 41 | 2 86 | 1 46 | 1 11 | 5 00 | 0 00 | 0 00 | 0 00 | 0.00 |
| 42 | 1 88 | 0 62 | 1 19 | 2 50 | 0 00 | 0 00 | 0 00 | 0 00 |
| 43 | 1 70 | 0 53 | 1 12 | 2 37 | 0 22 | 0 17 | 0 04 | 0 46 |
| 44 | 2 38 | 1 13 | 1 19 | 3.50 | 0 52 | 0 48 | 0 04 | 1 00 |
| 45 | 1 67 | 0 50 | 1 12 | 2 31 | 0 21 | 0 16 | 0 04 | 0 43 |
| 46 | 1 70 | 0 53 | 1 12 | 2 36 | 0 22 | 0 17 | 0 04 | 0 46 |
| 47 | 1 72 | 0 56 | 1 12 | 2 42 | 0 23 | 0 19 | 0 04 | 0 49 |
| 48 | 1 90 | 0 60 | 1 24 | 2 50 | 0 00 | 0 00 | 0 00 | 0 00 |
| 49 | 1 92 | 0 81 | 1 16 | 5 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| 50 | 1 57 | 0 44 | 1 10 | 2 09 | 0 18 | 0 16 | 0 03 | 0 75 |
| 51 | 2 39 | 1 21 | 1 16 | 5 00 | 0 61 | 0 79 | 0 03 | 4 57 |
| 52 | 1 58 | 0 44 | 1 10 | 2 10 | 0 18 | 0 16 | 0 03 | 0 76 |
| 53 | 1 57 | 0 43 | 1 10 | 2 04 | 0 17 | 0 15 | 0 03 | 0 75 |
| 54 | 1 57 | 0 44 | 1 10 | 2 09 | 0 18 | 0 16 | 0 03 | 0 75 |
| 55 | 1 59 | 0 45 | 1 10 | 2 12 | 0 18 | 0 15 | 0 03 | 0 76 |
| 56 | 1 8[illegible] | [illegible] 65 | 1 16 | 2 50 | 0 00 | 0 00 | 0 00 | 0 00 |
| 57 | 2 2[illegible] | [illegible] 96 | 1 02 | 4 84 | 0 00 | 0 00 | 0 00 | 0 00 |

Figure 4-36 Push Button Report (1 of 3)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | 1 | [illegible] | 500 | 0 | 0 | 1010 4 692 [illegible] | 130 7 2203 7 | 1013 8 689 99 | 130 7 2203 7 | 2 65 1 35 1 01 5 00 | 0 89 1 08 0 00 4 42 |
| [illegible] | [illegible] | 1 | [illegible] | 500 | 0 | 0 | 1013 8 689 99 | 130 7 2203 7 | 1026 3 710 12 | 130 7 2268 9 | 2 65 1 34 1 01 5 00 | 0 90 1 08 0 00 4 42 |
| [illegible] | SING | 1 | 00 | 500 | 0 | 0 | 974 6 681 00 | 102 4 2142 5 | 1100 7 725 53 | 189 6 2319 9 | 2 61 1 01 1 02 4 27 | 0 74 0 63 0 00 2 83 |
| [illegible] | SING | 1 | 00 | 200 | 0 | 0 | 1026 3 710 12 | 130 7 2268 9 | 1041 5 700 03 | 161 3 2268 9 | 2 66 1 35 1 01 5 00 | 0 98 1 25 0 00 4 42 |
| [illegible] | SING | 1 | 00 | 500 | 0 | 0 | 1041 5 700 03 | 161 3 2268 9 | 1047 4 692 84 | 191 4 2268 9 | 2 68 1 37 1 01 5 00 | 0 99 1 24 0 00 4 42 |
| [illegible] | MULT | 1 | 00 | 500 | 0 | 0 | 974 6 681 00 | 102 4 2142 5 | 1072 3 711 87 | 189 8 2322 4 | 2 50 1 21 1 01 5 00 | 0 77 0 90 0 00 3 96 |
| [illegible] | SING | 1 | 00 | 500 | 0 | 0 | 974 6 681 00 | 102 4 2142 5 | 1081 9 715 38 | 190 3 2323 0 | 2 61 1 28 1 01 5 00 | 0 82 0 93 0 00 4 11 |
| [illegible] | MULT | 1 | 00 | 500 | 0 | 0 | 1102 1 724 82 | 191 4 2323 0 | 1102 1 724 82 | 191 4 2323 0 | 2 65 1 38 1 02 5 00 | 0 00 0 00 0 00 0 00 |
| [illegible] | MULT | 1 | 00 | 100 | 0 | 0 | 0 0 0 00 | 0 0 0 0 | 0 0 0 00 | 0 0 0 0 | 1 00 0 00 1 00 1 00 | 0 00 0 00 0 00 0 00 |
| [illegible] | MULT | 1 | 00 | 103 | 3 | 0 | 0 0 0 00 | 0 0 0 0 | 0 0 0 00 | 0 0 0 0 | 1 00 0 00 1 00 1 00 | 0 00 0 00 0 00 0 00 |
| [illegible] | MULT | 1 | 00 | 100 | 0 | 0 | 0 0 0 00 | 0 0 0 0 | 31 0 1 00 | 28 6 32 6 | 1 00 0 00 1 00 1 00 | 0 00 0 00 0 00 0 00 |
| [illegible] | MULT | 1 | 00 | 103 | 3 | 0 | 31 2 1 72 | 28 6 42 7 | 43 1 6 72 | 29 4 61 2 | 1 00 0 00 1 00 1 00 | 0 00 0 00 0 00 0 00 |
| [illegible] | MULT | 1 | 00 | 100 | 0 | 0 | 43 3 6 75 | 29 4 61 2 | 53 5 8 05 | 37 2 76 2 | 1 00 0 00 1 00 1 00 | 0 00 0 00 0 00 0 00 |
| [illegible] | MULT | 1 | 00 | 100 | 0 | 0 | 53 5 8 05 | 37 2 76 2 | 110 9 7 46 | 96 0 131 7 | 1 03 0 01 1 02 1 05 | 0 01 0 00 0 00 0 01 |
| [illegible] | MULT | 1 | 00 | 100 | 0 | 0 | 53 5 8 05 | 37 2 76 2 | 63 2 8 29 | 41 9 82 2 | 1 02 0 00 1 01 1 03 | 0 01 0 00 0 00 0 01 |
| [illegible] | MULT | 1 | 00 | 102 | 2 | 0 | 63 3 8 25 | 41 9 82 2 | 74 9 9 77 | 48. 5 97 3 | 1 02 0 00 1 01 1 03 | 0 01 0. 00 0 00 0. 01 |
| [illegible] | MULT | 1 | 00 | 100 | 0 | 0 | 75 0 9 81 | 48 5 97 3 | 84 7 10 20 | 56 8 112 8 | 1 02 0 00 1 01 1 03 | 0 01 0 00 0 00 0 01 |
| [illegible] | MULT | 1 | 00 | 100 | 0 | 0 | 84 7 10 20 | 56 8 112 8 | 96 2 12 42 | 58. 5 125. 2 | 1 02 0 00 1 01 1 03 | 0 01 0 00 0 00 0 01 |
| [illegible] | MULT | 1 | 00 | 100 | 0 | 0 | 111 1 7 63 | 96 0 131 7 | 111 1 7 63 | 96 0 131 7 | 1 03 0 01 1 01 1 05 | 0 00 0 00 0 00 0 00 |
| [illegible] | MULT | 1 | 00 | 200 | 0 | 0 | 2082 9 388 97 | 1649 6 2997 6 | 2082 9 388 97 | 1649 6 2997 6 | 3 45 1 11 2 50 5. 00 | 0. 00 0. 00 0 00 0 00 |
| [illegible] | MULT | 1 | 00 | 200 | 0 | 0 | 2082 9 388 97 | 1649 6 2997 6 | 2099 5 372 92 | 1682 6 2997 6 | 3 39 1 42 2 00 5 00 | 1 47 1 49 0 29 4 57 |
| [illegible] | MULT | 1 | 00 | 200 | 0 | 0 | 2099 5 372 92 | 1682 6 2997 6 | 2109 5 378 43 | 1686 4 3013 3 | 3 31 1 38 2 00 5 00 | 1 41 1 48 0 29 4 57 |
| [illegible] | MULT | 1 | 00 | 200 | 0 | 0 | 2109 5 378 43 | 1686 4 3013 3 | 2109 5 378 43 | 1686 4 3013 3 | 3 37 1 41 2 00 5 00 | 1 46 1 49 0 29 4 57 |
| [illegible] | MULT | 1 | 00 | 200 | 0 | 0 | 2109 5 378 43 | 1686 4 3013 3 | 2109 5 378 43 | 1686 4 3013 3 | 3 37 1 41 2 00 5 00 | 1 46 1 49 0 29 4 57 |
| [illegible] | MULT | 1 | 00 | 200 | 0 | 0 | 2109 5 378 43 | 1686 4 3013 3 | 2109 5 378 43 | 1686 4 3013. 3 | 3 43 1 12 2 50 5 00 | 0 00 0 00 0 00 0 00 |
| 95 | MULT | 1 | 00 | 400 | 0 | 0 | 813 9 605 97 | 217 8 1844 6 | 813 9 605 97 | 217 8 1844 6 | 2 04 0 99 1. 05 4. 78 | 0 00 0 00 0 00 0. 00 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 813 9 605 97 | 217 8 1844 6 | 856 2 617 26 | 248 4 1902 5 | 2 25 1 19 1 03 4 74 | 0 62 0 67 0 01 3 21 |
| 97 | MULT | 1 | 00 | 400 | 0 | 0 | 856 2 617 26 | 248 4 1902 5 | 899 7 630 18 | 277 3 1965 4 | 2 42 1 39 1 03 5. 00 | 0. 72 0 82 0. 01 4 28 |
| [illegible] | SING | 1 | 00 | 400 | 0 | 0 | 856 2 617 26 | 248 4 1902 5 | 940 2 649 13 | 301 7 2019 9 | 2 69 1 62 1 08 5. 00 | 0. 88 1. 03 0 02 4 49 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 856 2 617 26 | 248 4 1902 5 | 921 1 642 31 | 305 6 2018 3 | 1 92 0 97 1 03 3. 50 | 0 38 0 41 0 01 1 17 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 899 7 630 18 | 277 3 1965 4 | 899 7 630 18 | 277 3 1965 4 | 2 62 1 61 1 05 5 00 | 1 05 1 33 0 02 4 57 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 899 7 630 18 | 277 3 1965 4 | 899 7 630 18 | 277 3 1965. 4 | 2 62 1 61 1 05 5. 00 | 1 05 1 33 0 02 4 57 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 943 1 647 37 | 305 6 2019 9 | 943 1 647 37 | 305 6 2019 9 | 2 51 1 58 1 08 5. 00 | 0. 00 0 00 0 00 0. 00 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 1175 4 671 94 | 446 2 2323 0 | 1175 4 671 94 | 446 2 2323 0 | 2 94 1 65 1 12 5. 00 | 0 00 0 00 0 00 0. 00 |
| 113 | MULT | 1 | 00 | 610 | 210 | 0 | 1466 9 771 32 | 446 2 2589 5 | 1486 4 783. 32 | 463 2 2624. 1 | 3 14 1 69 1 08 5. 00 | 1. 50 1 39 0. 02 4 57 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 1205 2 705 01 | 463 2 2624 1 | 1235 8 720 74 | 489 2 2689 3 | 2 49 1 50 1 08 5 00 | 1 34 1 82 0 02 4 57 |
| [illegible] | MULT | 1 | 00 | 495 | 95 | 0 | 1454 3 788 72 | 489 2 2689 3 | 1454 3 788 72 | 489 2 2689 3 | 2 97 1 67 1 08 5. 00 | 1 37 1 38 0 02 4 57 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 1235 8 720 74 | 489 2 2689 3 | 1235 8 720 74 | 489 2 2689 3 | 2 48 1 50 1 08 5 00 | 1 36 1 87 0 02 4 57 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 1235 8 720 74 | 489 2 2689 3 | 1235 8 720 74 | 489 2 2689 3 | 2 48 1 50 1 08 5 00 | 0 99 1 24 0. 02 4. 57 |

Figure 4-36 Push Button Report (2 of 3)

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD | BUSY TIME MIN | BUSY TIME MAX | IDLE TIME MEAN | IDLE TIME STD | IDLE TIME MIN | IDLE TIME MAX | TOTAL TIME USED MEAN | TOTAL TIME USED STD | TOTAL TIME USED MIN | TOTAL TIME USED MAX | STRESS MEAN | STRESS STD | STRESS MIN | STRESS MAX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2500 00 | 1869 4 | 139 1 | 1700 8 | 2397 4 | 624 4 | 23 9 | 582 3 | 704 4 | 2493 8 | 154 4 | 2318 4 | 3061 8 | 2. 19 | 0 19 | 1 90 | 2 77 |
| 2 | 2500 00 | 1817 3 | 158 5 | 1646 4 | 2373 8 | 676 5 | 24 7 | 615 7 | 729 4 | 2493 8 | 154 4 | 2318 4 | 3061.8 | 2 08 | 0. 21 | 1 77 | 2 70 |
| 3 | 2500 00 | 1817 3 | 158 5 | 1646 4 | 2373 8 | 676 5 | 24 7 | 615 7 | 729 4 | 2493 8 | 154 4 | 2318 4 | 3061.8 | 2 08 | 0 21 | 1 77 | 2 70 |
| 4 | 2500 00 | 1994 6 | 154 7 | 1832 2 | 2574 1 | 499 2 | 13 4 | 463 0 | 537 7 | 2493 8 | 154 4 | 2318 4 | 3061.8 | 2 18 | 0. 20 | 1 90 | 2 78 |
| 5 | 2500 00 | 1672 4 | 10 4 | 1655 2 | 1703 8 | 800 7 | 142 0 | 645 2 | 1345 9 | 2472 1 | 142 0 | 2305 5 | 3013 3 | 2 43 | 0. 09 | 2 33 | 2 74 |
| 6 | 2500 00 | 317 0 | 2 7 | 310 2 | 324 1 | 2156 1 | 142 3 | 1908 8 | 2700 2 | 2473 1 | 142 0 | 2305 5 | 3013 3 | 1 77 | 0 08 | 1 71 | 2 02 |
| 7 | 2500 00 | 317 0 | 2 7 | 310 2 | 324 1 | 2156 1 | 142 3 | 1908 8 | 2700. 2 | 2473 1 | 142 0 | 2305 5 | 3013 3 | 1 79 | 0 06 | 1 71 | 2 02 |

60 SUCCESSFUL MISSIONS

20 UNSUCCESSFUL MISSIONS

Figure 4-36  Push Button Report (3 of 3)

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD | BUSY TIME MIN | BUSY TIME MAX | IDLE TIME MEAN | IDLE TIME STD | IDLE TIME MIN | IDLE TIME MAX | TOTAL TIME USED MEAN | TOTAL TIME USED STD | TOTAL TIME USED MIN | TOTAL TIME USED MAX. | STRESS MEAN | STRESS STD. | STRESS MIN. | STRESS MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2500.00 | 1906.0 | 150.7 | 1742.2 | 2456.4 | 622.9 | 24.4 | 580.6 | 674.2 | 2528.9 | 167.8 | 2355.3 | 3112.0 | 2.25 | 0.20 | 1.97 | 2.84 |
| 2 | 2500.00 | 1859.8 | 175.0 | 1649.7 | 2441.3 | 659.1 | 27.8 | 603.8 | 715.7 | 2528.9 | 167.8 | 2355.3 | 3112.0 | 2.15 | 0.22 | 1.83 | 2.76 |
| 3 | 2500.00 | 1859.8 | 175.0 | 1649.7 | 2441.3 | 659.1 | 27.8 | 603.8 | 715.7 | 2528.9 | 167.8 | 2355.3 | 3112.0 | 2.15 | 0.22 | 1.83 | 2.76 |
| 4 | 2500.00 | 2034.7 | 169.0 | 1845.7 | 2635.0 | 494.2 | 14.3 | 455.1 | 528.9 | 2528.9 | 167.8 | 2355.3 | 3112.0 | 2.25 | 0.21 | 1.95 | 2.84 |
| 5 | 2500.00 | 1671.0 | 11.2 | 1650.8 | 1703.3 | 834.2 | 154.4 | 676.5 | 1397.9 | 2505.1 | 154.2 | 2341.5 | 3063.5 | 2.48 | 0.13 | 2.33 | 2.98 |
| 6 | 2500.00 | 315.9 | 4.0 | 305.7 | 339.6 | 2189.3 | 154.6 | 2025.2 | 2752.2 | 2505.1 | 154.2 | 2341.5 | 3063.5 | 1.80 | 0.09 | 1.71 | 2.05 |
| 7 | 2500.00 | 315.9 | 4.0 | 305.7 | 339.6 | 2189.3 | 154.6 | 2025.2 | 2752.2 | 2505.1 | 154.2 | 2341.5 | 3063.5 | 1.80 | 0.09 | 1.71 | 2.05 |

71 SUCCESSFUL MISSIONS

29 UNSUCCESSFUL MISSIONS

Figure 4-37 Light Pen Report (1 of 3)

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK NO | TASK TYPE | TASK ESS | ---COUNTERS--- REL | FAIL | SKIP | -----TIME TASK REALIZED---- MEAN | STD | MIN | MAX | ----TIME TASK COMPLETED---- MEAN | STD | MIN. | MAX | ----TASK STRESS---- MEAN | STD | MIN | MAX | -TASK COHESIVENESS- MEAN | STD. | MIN. | MAX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MULT | 1.00 | 103 | 3 | 0 | 112.8 | 10.87 | 96.0 | 168.8 | 142.5 | 23.32 | 96.0 | 209.9 | 1.02 | 0.00 | 1.01 | 1.03 | 0.01 | 0.00 | 0.00 | 0.01 |
| 2 | MULT | 1.00 | 102 | 2 | 0 | 231.1 | 21.98 | 185.5 | 293.8 | 256.4 | 21.97 | 212.0 | 327.6 | 1.04 | 0.02 | 1.01 | 1.09 | 0.01 | 0.00 | 0.00 | 0.02 |
| 3 | MULT | 1.00 | 101 | 1 | 0 | 255.9 | 22.00 | 212.0 | 327.6 | 255.9 | 22.00 | 212.0 | 327.6 | 1.04 | 0.01 | 1.01 | 1.09 | 0.01 | 0.00 | 0.00 | 0.02 |
| 4 | MULT | 1.00 | 100 | 0 | 0 | 339.6 | 19.85 | 300.3 | 405.9 | 339.6 | 19.85 | 300.3 | 405.9 | 1.08 | 0.02 | 1.05 | 1.14 | 0.02 | 0.00 | 0.01 | 0.04 |
| 5 | MULT | 1.00 | 128 | 28 | 0 | 472.3 | 17.64 | 436.3 | 525.9 | 486.7 | 18.37 | 446.1 | 538.8 | 1.10 | 0.02 | 1.07 | 1.16 | 0.03 | 0.00 | 0.02 | 0.05 |
| 6 | MULT | 1.00 | 100 | 0 | 0 | 530.0 | 20.72 | 490.2 | 586.8 | 538.6 | 20.63 | 497.7 | 589.8 | 1.12 | 0.02 | 1.08 | 1.18 | 0.03 | 0.01 | 0.02 | 0.05 |
| 7 | MULT | 1.00 | 120 | 20 | 0 | 640.1 | 20.23 | 598.2 | 695.5 | 653.0 | 20.13 | 607.0 | 709.8 | 1.15 | 0.03 | 1.10 | 1.22 | 0.04 | 0.01 | 0.03 | 0.06 |
| 8 | MULT | 1.00 | 101 | 1 | 0 | 652.8 | 20.35 | 607.0 | 709.8 | 659.2 | 20.22 | 613.9 | 716.0 | 1.15 | 0.03 | 1.10 | 1.22 | 0.04 | 0.01 | 0.03 | 0.06 |
| 9 | MULT | 1.00 | 127 | 27 | 0 | 731.9 | 18.29 | 690.2 | 779.3 | 743.5 | 18.45 | 700.3 | 790.3 | 1.22 | 0.03 | 1.16 | 1.31 | 0.06 | 0.01 | 0.04 | 0.09 |
| 10 | MULT | 1.00 | 101 | 1 | 0 | 744.0 | 18.91 | 700.3 | 790.3 | 749.6 | 18.75 | 704.9 | 796.0 | 1.22 | 0.03 | 1.16 | 1.31 | 0.06 | 0.01 | 0.04 | 0.09 |
| 11 | MULT | 1.00 | 110 | 10 | 0 | 1252.6 | 32.25 | 1179.5 | 1338.3 | 1262.0 | 31.85 | 1194.1 | 1345.3 | 2.00 | 0.00 | 2.00 | 2.00 | 0.53 | 0.24 | 0.29 | 0.76 |
| 12 | MULT | 1.00 | 115 | 15 | 0 | 1291.5 | 30.46 | 1220.1 | 1375.4 | 1300.5 | 30.70 | 1232.6 | 1386.8 | 2.00 | 0.00 | 2.00 | 2.00 | 0.46 | 0.23 | 0.29 | 0.76 |
| 13 | MULT | 1.00 | 101 | 1 | 0 | 1758.3 | 32.25 | 1688.5 | 1844.6 | 1775.7 | 34.39 | 1694.9 | 1853.2 | 2.00 | 0.00 | 2.00 | 2.00 | 0.29 | 0.00 | 0.29 | 0.29 |
| 14 | MULT | 1.00 | 131 | 31 | 0 | 2449.9 | 121.13 | 2287.9 | 2878.2 | 2470.2 | 137.81 | 2297.8 | 2927.0 | 3.15 | 1.38 | 2.00 | 5.00 | 1.68 | 1.49 | 0.32 | 4.57 |
| 15 | MULT | 1.00 | 100 | 0 | 0 | 2505.1 | 154.23 | 2341.5 | 3063.5 | 2528.9 | 167.78 | 2355.3 | 3112.0 | 2.84 | 1.33 | 2.00 | 5.00 | 1.60 | 1.83 | 0.29 | 4.57 |
| 20 | MULT | 1.00 | 100 | 0 | 0 | 2434.6 | 122.33 | 2297.8 | 2927.0 | 2434.6 | 122.33 | 2297.6 | 2927.0 | 3.04 | 1.02 | 2.50 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 21 | SING | 1.00 | 100 | 0 | 0 | 2434.6 | 122.33 | 2297.8 | 2927.0 | 2434.6 | 122.33 | 2297.8 | 2927.0 | 2.66 | 1.22 | 2.00 | 5.00 | 1.19 | 1.73 | 0.29 | 4.57 |
| 22 | SING | 1.00 | 100 | 0 | 0 | 2434.6 | 122.33 | 2297.8 | 2927.0 | 2462.1 | 138.49 | 2314.7 | 2991.3 | 2.66 | 1.22 | 2.00 | 5.00 | 1.19 | 1.73 | 0.29 | 4.57 |
| 23 | MULT | 1.00 | 100 | 0 | 0 | 2434.6 | 122.33 | 2297.8 | 2927.0 | 2489.3 | 154.02 | 2330.9 | 3047.8 | 2.73 | 1.22 | 2.00 | 5.00 | 1.24 | 1.74 | 0.29 | 4.57 |
| 24 | SING | 1.00 | 100 | 0 | 0 | 2434.6 | 122.33 | 2297.8 | 2927.0 | 2489.3 | 153.89 | 2331.1 | 3047.0 | 2.73 | 1.22 | 2.00 | 5.00 | 1.24 | 1.74 | 0.29 | 4.57 |
| 25 | MULT | 1.00 | 100 | 0 | 0 | 2489.5 | 154.06 | 2331.1 | 3047.8 | 2489.5 | 154.06 | 2331.1 | 3047.8 | 3.17 | 1.12 | 2.50 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 26 | MULT | 1.00 | 100 | 0 | 0 | 909.0 | 32.48 | 834.5 | 994.9 | 909.0 | 32.48 | 834.5 | 994.9 | 1.78 | 0.18 | 1.45 | 2.36 | 0.00 | 0.00 | 0.00 | 0.00 |
| 27 | SING | 1.00 | 100 | 0 | 0 | 909.0 | 32.48 | 834.5 | 994.9 | 926.7 | 31.57 | 855.2 | 1011.9 | 1.52 | 0.12 | 1.30 | 1.90 | 0.15 | 0.03 | 0.09 | 0.26 |
| 28 | SING | 1.00 | 100 | 0 | 0 | 909.0 | 32.48 | 834.5 | 994.9 | 941.5 | 32.76 | 869.[illegible] | 1029.4 | 1.78 | 0.18 | 1.45 | 2.36 | 0.15 | 0.03 | 0.09 | 0.26 |
| 29 | SING | 1.00 | 100 | 0 | 0 | 926.7 | 31.57 | 855.2 | 1011.9 | 926.7 | 31.57 | 855.2 | 1011.9 | 1.52 | 0.12 | 1.30 | 1.90 | 0.15 | 0.03 | 0.09 | 0.26 |
| 30 | SING | 1.00 | 100 | 0 | 0 | 926.7 | 31.57 | 855.2 | 1011.9 | 944.2 | 30.65 | 875.2 | 1028.5 | 1.52 | 0.12 | 1.30 | 1.90 | 0.15 | 0.03 | 0.09 | 0.26 |
| 31 | MULT | 1.00 | 100 | 0 | 0 | 909.0 | 32.48 | 834.5 | 994.9 | 943.1 | 30.82 | 874.3 | 1027.6 | 1.52 | 0.12 | 1.30 | 1.90 | 0.15 | 0.03 | 0.09 | 0.26 |
| 32 | SING | 1.00 | 100 | 0 | 0 | 909.0 | 32.48 | 834.5 | 994.9 | 943.1 | 30.81 | 874.6 | 1027.3 | 1.52 | 0.12 | 1.30 | 1.90 | 0.15 | 0.03 | 0.09 | 0.26 |
| 33 | MULT | 1.00 | 100 | 0 | 0 | 944.4 | 30.97 | 875.2 | 1029.4 | 944.4 | 30.97 | 875.2 | 1029.4 | 1.79 | 0.20 | 1.44 | 2.45 | 0.00 | 0.00 | 0.00 | 0.00 |
| 34 | MULT | 1.00 | 300 | 0 | 0 | 1164.5 | 629.57 | 381.0 | 2037.2 | 1164.5 | 629.57 | 381.0 | 2037.2 | 2.97 | 1.58 | 1.11 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 35 | SING | 1.00 | 300 | 0 | 0 | 1164.5 | 629.57 | 381.0 | 2037.2 | 1260.6 | 658.57 | 431.8 | 2159.1 | 3.22 | 1.59 | 1.11 | 5.00 | 1.87 | 1.89 | 0.02 | 4.57 |
| 36 | SING | 1.00 | 300 | 0 | 0 | 1164.5 | 629.57 | 381.0 | 2037.2 | 1193.7 | 644.88 | 408.5 | 2102.3 | 3.25 | 1.62 | 1.07 | 5.00 | 1.89 | 1.87 | 0.02 | 4.57 |
| 37 | SING | 1.00 | 300 | 0 | 0 | 1193.7 | 644.88 | 408.5 | 2102.3 | 1214.6 | 643.38 | 408.5 | 2102.3 | 3.33 | 1.65 | 1.07 | 5.00 | 1.91 | 1.83 | 0.02 | 4.57 |
| 38 | MULT | 1.00 | 300 | 0 | 0 | 1164.5 | 629.57 | 381.0 | 2037.2 | 1260.6 | 655.96 | 433.3 | 2155.0 | 3.20 | 1.61 | 1.07 | 5.00 | 1.83 | 1.84 | 0.02 | 4.57 |
| 39 | SING | 1.00 | 300 | 0 | 0 | 1214.6 | 643.38 | 408.5 | 2102.3 | 1264.7 | 657.43 | 435.3 | 2159.0 | 3.32 | 1.64 | 1.07 | 5.00 | 1.95 | 1.89 | 0.02 | 4.57 |
| 40 | SING | 1.00 | 300 | 0 | 0 | 1164.5 | 629.57 | 381.0 | 2037.2 | 1261.5 | 656.88 | 434.9 | 2157.8 | 3.29 | 1.63 | 1.07 | 5.00 | 1.90 | 1.88 | 0.02 | 4.57 |
| 41 | MULT | 1.00 | 300 | 0 | 0 | 1265.4 | 656.01 | 436.3 | 2159.1 | 1265.4 | 658.01 | 436.3 | 2159.1 | 2.79 | 1.38 | 1.11 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 42 | MULT | 1.00 | 200 | 0 | 0 | 1129.7 | 472.54 | 613.9 | 1687.3 | 1129.7 | 472.54 | 613.9 | 1687.3 | 1.89 | 0.62 | 1.18 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 43 | SING | 1.00 | 200 | 0 | 0 | 1129.7 | 472.54 | 613.9 | 1687.3 | 1150.8 | 469.67 | 640.1 | 1705.6 | 1.73 | 0.55 | 1.12 | 2.40 | 0.23 | 0.18 | 0.03 | 0.48 |
| 44 | SING | 1.00 | 200 | 0 | 0 | 1129.7 | 472.54 | 613.9 | 1687.3 | 1210.4 | 511.92 | 660.0 | 1807.2 | 2.39 | 1.12 | 1.18 | 3.50 | 0.53 | 0.48 | 0.03 | 1.00 |
| 45 | MULT | 1.00 | 200 | 0 | 0 | 1129.7 | 472.54 | 613.9 | 1687.3 | 1170.1 | 466.81 | 664.1 | 1722.4 | 1.70 | 0.52 | 1.12 | 2.34 | 0.22 | 0.17 | 0.03 | 0.45 |
| 46 | SING | 1.00 | 200 | 0 | 0 | 1150.8 | 469.67 | 640.1 | 1705.6 | 1191.2 | 464.00 | 690.2 | 1740.4 | 1.72 | 0.54 | 1.12 | 2.40 | 0.23 | 0.18 | 0.03 | 0.47 |
| 47 | SING | 1.00 | 200 | 0 | 0 | 1129.7 | 472.54 | 613.9 | 1687.3 | 1170.2 | 466.90 | 663.7 | 1721.7 | 1.75 | 0.57 | 1.12 | 2.45 | 0.24 | 0.19 | 0.03 | 0.50 |
| 48 | MULT | 1.00 | 200 | 0 | 0 | 1224.7 | 497.53 | 690.2 | 1807.[illegible] | 1224.7 | 497.53 | 690.2 | 1807.2 | 1.91 | 0.59 | 1.23 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 49 | MULT | 1.00 | 200 | 0 | 0 | 943.9 | 358.29 | 546.0 | 1388.8 | 943.9 | 358.29 | 546.0 | 1388.8 | 1.93 | 0.80 | 1.15 | 5.00 | 0.00 | 0.00 | 0.00 | 0.[illegible] |
| 50 | SING | 1.00 | 200 | 0 | 0 | 943.9 | 358.29 | 546.0 | 1388.8 | 952.6 | 367.01 | 546.0 | 1406.0 | 1.59 | 0.44 | 1.10 | 2.11 | 0.18 | 0.16 | 0.03 | 0.76 |
| 51 | SING | 1.00 | 200 | 0 | 0 | 943.9 | 358.29 | 546.0 | 1388.8 | 1025.7 | 396.41 | 594.0 | 1508.9 | 2.40 | 1.20 | 1.15 | 5.00 | 0.61 | 0.79 | 0.03 | 4.57 |
| 52 | SING | 1.00 | 200 | 0 | 0 | 952.6 | 367.01 | 546.0 | 1406.0 | 973.7 | 363.27 | 572.3 | 1423.4 | 1.60 | 0.45 | 1.10 | 2.13 | 0.19 | 0.16 | 0.03 | 0.7[illegible] |
| 53 | MULT | 1.00 | 200 | 0 | 0 | 943.9 | 358.29 | 546.0 | 1388.8 | 984.5 | 350.86 | 597.5 | 1422.5 | 1.58 | 0.43 | 1.10 | 2.06 | 0.18 | 0.15 | 0.03 | 0.7[illegible] |
| 54 | SING | 1.00 | 200 | 0 | 0 | 973.7 | 363.27 | 572.3 | 1423.4 | 994.7 | 359.50 | 598.2 | 1439.6 | 1.59 | 0.44 | 1.10 | 2.12 | 0.18 | 0.16 | 0.03 | 0.7[illegible] |
| 55 | SING | 1.00 | 200 | 0 | 0 | 943.9 | 358.29 | 546.0 | 1388.8 | 984.8 | 351.08 | 597.4 | 1423.1 | 1.61 | 0.46 | 1.10 | 2.15 | 0.19 | 0.16 | 0.03 | 0.77 |
| 56 | MULT | [illegible] | 200 | 0 | 0 | 1028.7 | 393.39 | 598.[illegible] | [illegible]508.9 | 1028.7 | 393.39 | 598.2 | 1508.9 | 1.8[illegible] | [illegible].64 | 1.15 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 57 | [illegible] | [illegible] | 200 | 0 | 0 | 988.6 | 684.81 | 96.[illegible] | 2159.1 | 988.6 | 684.81 | 96.0 | 2159.1 | 2.3[illegible] | [illegible].06 | 1.01 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Figure 4-37 Light Pen Report (2 of 3)

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [illegible] | SING | 1.[illegible] | [illegible]00 | 0 | 0 | 1025.[illegible] | 696.37 | 124.4 | 2217.[illegible] | 1028.5 | 694.14 | 124.4 | 2217.7 | 2.68 | 1.35 | 1.01 | 5.00 | 1.00 | 1.28 | 0.00 | 4.57 |
| [illegible] | SING | 1.00 | 500 | 0 | 0 | 1028.5 | 694.14 | 124.4 | 2217.7 | 1041.0 | 714.29 | 124.4 | 2280.2 | 2.69 | 1.34 | 1.01 | 5.00 | 1.00 | 1.27 | 0.00 | 4.57 |
| 61 | SING | 1.00 | 500 | 0 | 0 | 988.6 | 684.81 | 96.0 | 2159.1 | 1115.4 | 729.33 | 183.9 | 2339.5 | 2.66 | 1.04 | 1.01 | 4.43 | 0.80 | 0.73 | 0.00 | 3.08 |
| [illegible] | SING | 1.00 | 500 | 0 | 0 | 1041.0 | 714.29 | 124.4 | 2280.2 | 1056.5 | 704.18 | 155.2 | 2280.2 | 2.69 | 1.35 | 1.01 | 5.00 | 1.06 | 1.37 | 0.00 | 4.57 |
| 63 | SING | 1.00 | 500 | 0 | 0 | 1056.5 | 704.18 | 155.2 | 2280.2 | 1062.3 | 697.16 | 185.5 | 2280.2 | 2.71 | 1.37 | 1.01 | 5.00 | 1.07 | 1.37 | 0.00 | 4.57 |
| 64 | MULT | 1.00 | 500 | 0 | 0 | 988.6 | 684.81 | 96.0 | 2159.1 | 1089.3 | 717.37 | 183.9 | 2342.1 | 2.57 | 1.28 | 1.01 | 5.00 | 0.86 | 1.07 | 0.00 | 4.35 |
| 65 | SING | 1.00 | 500 | 0 | 0 | 988.6 | 684.81 | 96.0 | 2159.1 | 1097.1 | 719.75 | 184.4 | 2334.0 | 2.66 | 1.31 | 1.01 | 5.00 | 0.91 | 1.11 | 0.00 | 4.52 |
| [illegible] | MULT | 1.00 | 500 | 0 | 0 | 1117.0 | 728.63 | 185.5 | 2342.1 | 1117.0 | 728.63 | 185.5 | 2342.1 | 2.68 | 1.38 | 1.02 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | MULT | 1.00 | 100 | 0 | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | MULT | 1.00 | 103 | 3 | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | MULT | 1.00 | 100 | 0 | 0 | 0.0 | 0.00 | 0.0 | 0.0 | 31.0 | 1.04 | 28.6 | 32.6 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | MULT | 1.00 | 104 | 4 | 0 | 31.3 | 2.29 | 28.6 | 46.4 | 43.3 | 6.81 | 29.4 | 61.2 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | MULT | 1.00 | 100 | 0 | 0 | 43.4 | 6.86 | 29.4 | 61.2 | 54.0 | 8.19 | 37.2 | 76.2 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | MULT | 1.00 | 100 | 0 | 0 | 54.0 | 8.19 | 37.2 | 76.2 | 111.3 | 7.58 | 96.0 | 131.7 | 1.03 | 0.01 | 1.02 | 1.05 | 0.01 | 0.00 | 0.00 | 0.01 |
| [illegible] | MULT | 1.00 | 100 | 0 | 0 | 54.0 | 8.19 | 37.2 | 76.2 | 63.8 | 8.39 | 41.9 | 82.2 | 1.02 | 0.00 | 1.01 | 1.03 | 0.01 | 0.00 | 0.00 | 0.01 |
| [illegible] | MULT | 1.00 | 103 | 3 | 0 | 64.0 | 8.34 | 41.9 | 82.2 | 75.2 | 10.18 | 48.5 | 97.3 | 1.02 | 0.00 | 1.01 | 1.03 | 0.01 | 0.00 | 0.00 | 0.01 |
| [illegible] | MULT | 1.00 | 100 | 0 | 0 | 75.4 | 10.27 | 48.5 | 97.3 | 85.2 | 10.99 | 56.8 | 112.8 | 1.02 | 0.00 | 1.01 | 1.03 | 0.01 | 0.00 | 0.00 | 0.01 |
| [illegible] | MULT | 1.00 | 100 | 0 | 0 | 85.[illegible] | 10.99 | 56.8 | 112.8 | 96.3 | 12.61 | 58.5 | 125.2 | 1.02 | 0.00 | 1.01 | 1.03 | 0.01 | 0.00 | 0.00 | 0.01 |
| [illegible] | MULT | 1.00 | 100 | 0 | 0 | 111.7 | 7.84 | 96.0 | 131.7 | 111.7 | 7.84 | 96.0 | 131.7 | 1.03 | 0.01 | 1.01 | 1.05 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | MULT | 1.00 | 200 | 0 | 0 | 2104.9 | 401.19 | 1651.1 | 3047.8 | 2104.9 | 401.19 | 1651.1 | 3047.8 | 3.59 | 1.17 | 2.50 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | MULT | 1.00 | 200 | 0 | 0 | 2104.9 | 401.19 | 1651.1 | 3047.8 | 2121.5 | 385.21 | 1684.3 | 3047.8 | 3.46 | 1.47 | 2.00 | 5.00 | 1.68 | 1.65 | 0.29 | 4.57 |
| [illegible] | MULT | 1.00 | 200 | 0 | 0 | 2121.5 | 385.21 | 1684.3 | 3047.8 | 2131.6 | 390.66 | 1688.5 | 3063.5 | 3.41 | 1.44 | 2.00 | 5.00 | 1.63 | 1.65 | 0.29 | 4.57 |
| [illegible] | MULT | 1.00 | 200 | 0 | 0 | 2131.6 | 390.66 | 1688.5 | 3063.5 | 2131.6 | 390.66 | 1688.5 | 3063.5 | 3.45 | 1.47 | 2.00 | 5.00 | 1.67 | 1.65 | 0.29 | 4.57 |
| [illegible] | MULT | 1.00 | 200 | 0 | 0 | 2131.6 | 390.66 | 1688.5 | 3063.5 | 2131.6 | 390.66 | 1688.5 | 3063.5 | 3.45 | 1.47 | 2.00 | 5.00 | 1.67 | 1.65 | 0.29 | 4.57 |
| [illegible] | MULT | 1.00 | 200 | 0 | 0 | 2131.6 | 390.66 | 1688.5 | 3063.5 | 2131.6 | 390.66 | 1688.5 | 3063.5 | 3.58 | 1.17 | 2.50 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 95 | MULT | 1.00 | 400 | 0 | 0 | 828.9 | 608.99 | 212.0 | 1853.2 | 828.9 | 608.99 | 212.0 | 1853.2 | 2.09 | 1.04 | 1.04 | 4.90 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | MULT | 1.00 | 400 | 0 | 0 | 828.9 | 608.99 | 212.0 | 1853.2 | 871.8 | 621.54 | 242.8 | 1912.8 | 2.31 | 1.25 | 1.03 | 4.83 | 0.67 | 0.74 | 0.01 | 3.39 |
| [illegible] | MULT | 1.00 | 400 | 0 | 0 | 871.8 | 621.54 | 242.8 | 1912.8 | 915.9 | 635.78 | 271.9 | 1976.8 | 2.49 | 1.45 | 1.03 | 5.00 | 0.79 | 0.93 | 0.01 | 4.48 |
| 98 | SING | 1.00 | 400 | 0 | 0 | 871.8 | 621.54 | 242.8 | 1912.8 | 955.2 | 653.77 | 296.6 | 2037.2 | 2.70 | 1.62 | 1.07 | 5.00 | 0.95 | 1.14 | 0.01 | 4.57 |
| [illegible] | MULT | 1.00 | 400 | 0 | 0 | 871.8 | 621.54 | 242.8 | 1912.8 | 936.4 | 647.07 | 300.3 | 2034.5 | 1.94 | 0.99 | 1.03 | 3.50 | 0.40 | 0.42 | 0.01 | 1.24 |
| 100 | MULT | 1.00 | 400 | 0 | 0 | 915.9 | 635.78 | 271.9 | 1976.8 | 915.9 | 635.78 | 271.9 | 1976.8 | 2.68 | 1.64 | 1.05 | 5.00 | 1.14 | 1.46 | 0.01 | 4.57 |
| 101 | MULT | 1.00 | 400 | 0 | 0 | 915.9 | 635.78 | 271.9 | 1976.8 | 915.9 | 635.79 | 271.9 | 1976.8 | 2.68 | 1.64 | 1.05 | 5.00 | 1.14 | 1.46 | 0.01 | 4.57 |
| 102 | MULT | 1.00 | 400 | 0 | 0 | 958.3 | 651.93 | 300.3 | 2037.2 | 958.3 | 651.93 | 300.3 | 2037.2 | 2.56 | 1.58 | 1.08 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 117 | MULT | 1.00 | 400 | 0 | 0 | 1189.1 | 678.48 | 446.1 | 2342.1 | 1189.1 | 678.48 | 446.1 | 2342.1 | 2.85 | 1.60 | 1.12 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 118 | MULT | 1.00 | 600 | 200 | 0 | 1471.4 | 781.66 | 446.1 | 2639.7 | 1490.6 | 793.57 | 463.0 | 2674.3 | 3.13 | 1.69 | 1.08 | 5.00 | 1.65 | 1.62 | 0.02 | 4.57 |
| 119 | MULT | 1.00 | 400 | 0 | 0 | 1217.9 | 710.30 | 463.0 | 2674.3 | 1248.5 | 726.19 | 490.2 | 2739.5 | 2.51 | 1.49 | 1.08 | 5.00 | 1.34 | 1.86 | 0.02 | 4.57 |
| 120 | MULT | 1.00 | 490 | 90 | 0 | 1456.6 | 794.52 | 490.2 | 2739.5 | 1456.6 | 794.52 | 490.2 | 2739.5 | 2.95 | 1.66 | 1.08 | 5.00 | 1.49 | 1.59 | 0.02 | 4.57 |
| 121 | MULT | 1.00 | 400 | 0 | 0 | 1248.5 | 726.19 | 490.2 | 2739.5 | 1248.5 | 726.19 | 490.2 | 2739.5 | 2.50 | 1.49 | 1.08 | 5.00 | 1.35 | 1.88 | 0.02 | 4.57 |
| 122 | MULT | 1.00 | 400 | 0 | 0 | 1248.5 | 726.19 | 490.2 | 2739.5 | 1248.5 | 726.19 | 490.2 | 2739.5 | 2.50 | 1.49 | 1.08 | 5.00 | 1.06 | 1.41 | 0.02 | 4.57 |

Figure 4-37 Light Pen Report (3 of 3)

4.1.3.3.1 Dynamic Test/Mapping Display (Cont'd)

Table 4-11 Value Summary

| | | Keyboard | Push Button | Light Pen |
|---|---|---|---|---|
| Mean time of completion (seconds) | | 2507.9 | 2493.8 | 2528.9 |
| Mean stress/operator | 1 | 2.22 | 2.19 | 2.25 |
| | 2 | 2.11 | 2.08 | 2.15 |
| | 3 | 2.11 | 2.08 | 2.15 |
| | 4 | 2.22 | 2.18 | 2.25 |
| | 5 | 2.44 | 2.43 | 2.48 |
| | 6 | 1.79 | 1.78 | 1.80 |
| | 7 | 1.79 | 1.78 | 1.80 |
| Successful missions/100 | | 77 | 80 | 71 |
| Time allowed for mission (seconds) | | 2500 | 2500 | 2500 |

In the comparison of the use of the three interfacing methods to arrange mapping displays, the push button technique yielded the best results. The average time of completion was 6.25 seconds less than the allowed time while both other methods exceeded the allowed mission time. The push button interface had the highest percentage (80%) of successful missions. The operators felt an average of 2.36% less stress than the operators using a light pen, and an average of 0.87% less stress than the operators using a keyboard.

The keyboard was better suited than the light pen to the mapping task, but not by the large margin by which the push button surpassed the keyboard. The keyboard average time of completion was 0.31% greater than the assigned time while the light pen exceeded this time by 1.15%. The keyboard had a 6% higher success rate than did the light pen. The keyboard operators felt 1.29% less stress than the light pen operators.

In view of these results, of the three candidate interface methods, the push button interface was the best suited device for arranging a mapping display, followed by the keyboard. The light pen interfacing method was unsuitable.

4.1.3.3.2 Dynamic Test/Activate Discrete Malfunction. Discrete malfunctions are activated four times in leg 6 of the RTP. Task 118 is the activation task. The parameter set from the keyboard/malfunction TAM was inserted into the RTP for task 118. The probability of successful completion of task 118 was set at 0.97 and the probability of failure at 0.03.

The results of running the RTP with the keyboard interface handling the activation of discrete malfunction tasks are shown in Figure 4-38. There were 88/100 successful missions. Task 118 failed 98 times. However,

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD | BUSY TIME MIN | BUSY TIME MAX | IDLE TIME MEAN | IDLE TIME STD | IDLE TIME MIN | IDLE TIME MAX | TOTAL TIME USED MEAN | TOTAL TIME USED STD | TOTAL TIME USED MIN | TOTAL TIME USED MAX | STRESS MEAN | STRESS STD | STRESS MIN | STRESS MAX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | [illegible] | 1807 1 | [illegible] | [illegible] | 2173 7 | [illegible] | 10 4 | 570 0 | 682 6 | 2432 6 | 100 3 | [illegible] 8 | 2830 1 | 2 09 | 0 15 | 1 81 | 2 61 |
| 2 | [illegible] | [illegible] | [illegible] | [illegible] | 2141 1 | [illegible] | 10 1 | 523 9 | 722 0 | 2432 6 | 100 3 | 2290 8 | 2830 1 | 1 98 | 0 16 | 1 66 | 2 55 |
| 3 | [illegible] | 1747 3 | [illegible] 7 | [illegible] 9 | 2141 1 | 685 2 | 10 1 | 523 9 | 722 0 | 2432 6 | 100 3 | 2290 8 | 2830 1 | 1 98 | 0 16 | 1 68 | 2 55 |
| 4 | [illegible] | 1927 1 | 105 8 | 1742 4 | 2319 9 | 505 4 | 17 7 | 473 5 | 562 9 | 2432 6 | 100 3 | 2290 8 | 2830 1 | 2 09 | 0 15 | 1 79 | 2 60 |
| 5 | [illegible] 00 | [illegible] 3 | 11 7 | 1646 7 | 1730 2 | 749 3 | 07 7 | 610 1 | 1117 1 | 2414 6 | 90 5 | 2277 3 | 2782 0 | 2 40 | 0 07 | 2 32 | 2 71 |
| 6 | [illegible] 00 | 317 4 | 6 3 | 308 2 | 374 4 | 2097 2 | 89 5 | 1957 0 | 2460 1 | 2414 6 | 90 5 | 2277 3 | 2782 0 | 1 77 | 0 06 | 1 70 | 2 07 |
| 7 | [illegible] | 317 4 | 6 3 | 308 2 | 374 4 | 2097 2 | 89 5 | 1957 0 | 2460 1 | 2414 6 | 90 5 | 2277 3 | 2782 0 | 1.77 | 0 06 | 1 70 | 2.07 |

[illegible] SUCCESSFUL MISSIONS

12 UNSUCCESSFUL MISSIONS

Figure 4-38 RTP Leg 6 Keyboard Report (1 of 3)

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| [illegible] | [illegible] | TA | [illegible] | [illegible] | [illegible] | TIME TASK REALIZED MEAN | STD | MIN | MAX | TIME TASK COMPLETED MEAN | STD | MIN | MAX | TASK STRESS MEAN | STD | MIN | MAX | TASK COHESIVENESS MEAN | STD | MIN | MAX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | HOL 1 | 1 00 | 112 | 12 | 0 | 112 7 | 8 63 | 95 7 | 144 7 | 128 3 | 15 62 | 96 8 | 178 2 | 1 02 | 0 00 | 1 01 | 1 04 | 0 01 | 0 00 | 0 00 | 0 01 |
| [illegible] | HOL 1 | 1 00 | [illegible] | [illegible] | 0 | 215 0 | 15 50 | 187 4 | 263 0 | 244 2 | 15 80 | 210 0 | 287 3 | 1 03 | 0 01 | 1 01 | 1 06 | 0 01 | 0 00 | 0 00 | 0 02 |
| [illegible] | HOL 1 | 1 00 | 100 | 0 | 0 | 244 0 | 15 88 | 210 0 | 287 3 | 244 0 | 15 88 | 210 0 | 287 3 | 1 03 | 0 01 | 1 01 | 1 06 | 0 01 | 0 00 | 0 00 | 0 02 |
| 4 | HOL 1 | [illegible] | [illegible] | 0 | 0 | 328 2 | 14 57 | 297 0 | 367 4 | 328 2 | 14 57 | 297 0 | 367 4 | 1 07 | 0 01 | 1 05 | 1 10 | 0 02 | 0 00 | 0 01 | 0 03 |
| [illegible] | HOL 1 | 1 00 | [illegible] | 20 | 0 | 461 [illegible] | 13 41 | 431 2 | 495 8 | 475 9 | 14 03 | 444 1 | 520 0 | 1 09 | 0 01 | 1 07 | 1 12 | 0 03 | 0 00 | 0 02 | 0 04 |
| 6 | HOL 1 | 1 00 | 102 | 2 | 0 | 515 9 | 14 92 | 475 3 | 549 1 | 524 6 | 15 24 | 484 3 | 562 1 | 1 11 | 0 01 | 1 08 | 1 16 | 0 03 | 0 00 | 0 02 | 0 04 |
| 7 | HOL 1 | 1 00 | 101 | [illegible] | 0 | [illegible] 1 | 17 [illegible] | 587 2 | 678 8 | 642 7 | 18 39 | 600 0 | 712 5 | 1 13 | 0 02 | 1 09 | 1 18 | 0 04 | 0 01 | 0 03 | 0 05 |
| 8 | HOL 1 | 1 00 | 101 | 1 | 0 | 642 6 | 17 68 | 609 0 | 712 5 | 649 1 | 17 71 | 614 1 | 719 8 | 1 13 | 0 02 | 1 09 | 1 18 | 0 04 | 0 00 | 0 03 | 0 05 |
| 9 | HOL 1 | 1 00 | 118 | 18 | 0 | [illegible] 1 | 16 65 | 688 5 | 795 0 | 734 1 | 17 22 | 701 8 | 809 2 | 1 20 | 0 03 | 1 15 | 1 32 | 0 06 | 0 01 | 0 04 | 0 07 |
| 10 | HOL 1 | [illegible] | 100 | 0 | 0 | [illegible] 5 | 16 04 | 701 8 | 809 2 | 740 4 | 16 58 | 708 3 | 814 6 | 1 20 | 0 03 | 1 15 | 1 32 | 0 06 | 0 01 | 0 04 | 0 07 |
| 11 | HOL 1 | [illegible] | [illegible] | [illegible] | 0 | [illegible] 7 | [illegible] | 1176 6 | 1372 9 | 1245 1 | 28 66 | 1186 1 | 1384 2 | 2 00 | 0 00 | 2 00 | 2 00 | 0 65 | 0 21 | 0 29 | 0 76 |
| 12 | HOL 1 | [illegible] | 109 | 9 | 0 | [illegible] | [illegible] 23 | [illegible] 1 | 1411 6 | 1280 8 | 30 31 | 1219 4 | 1424 3 | 2 00 | 0 00 | 2 00 | 2 00 | 0 57 | 0 23 | 0 29 | 0 76 |
| 13 | HOL 1 | [illegible] | [illegible] | 1 | 0 | [illegible] 4 | 31 51 | 1677 2 | 1883 4 | 1751 9 | 31 35 | 1690 2 | 1895 9 | 2 00 | 0 00 | 2 00 | 2 00 | 0 29 | 0 00 | 0 29 | 0 29 |
| 14 | HOL 1 | [illegible] | [illegible] | [illegible] | 0 | 2355 1 | 71 79 | 2223 4 | 2643 5 | 2364 9 | 77 76 | 2273 5 | 2653 7 | 2 31 | 0 82 | 2 00 | 5 00 | 0 74 | 0 82 | 0 32 | 4 57 |
| 15 | HOL 1 | [illegible] | [illegible] | [illegible] | 0 | 2414 6 | 96 50 | 2277 3 | 2782 0 | 2432 6 | 100 30 | 2290 8 | 2830 1 | 2 25 | 0 95 | 2 00 | 5 00 | 0 83 | 1 34 | 0 29 | 4 57 |
| [illegible] | HOL 1 | [illegible] | 100 | 0 | 0 | 2358 0 | 69 97 | 2233 5 | 2653 7 | 2358 0 | 69 97 | 2233 5 | 2653 7 | 2 65 | 0 60 | 2 50 | 5 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | SHG | [illegible] | 100 | 0 | 0 | 2358 0 | 69 97 | 2233 5 | 2653 7 | 2358 0 | 69 97 | 2233 5 | 2653 7 | 2 21 | 0 72 | 2 00 | 5 00 | 0 55 | 0 99 | 0 29 | 4 57 |
| [illegible] | SHG | [illegible] | 100 | 0 | 0 | 2358 0 | 69 97 | 2233 5 | 2653 7 | 2378 8 | 78 89 | 2250 9 | 2719 0 | 2 21 | 0 72 | 2 00 | 5 00 | 0 55 | 0 99 | 0 29 | 4 57 |
| [illegible] | HOL 1 | 1 00 | 100 | 0 | 0 | 2358 0 | 69 97 | 2233 5 | 2653 7 | 2399 8 | 90 61 | 2266 9 | 2774 4 | 2 26 | 0 76 | 2 00 | 5 00 | 0 58 | 1 03 | 0 29 | 4 57 |
| [illegible] | SHG | 1 00 | [illegible] | [illegible] | 0 | 2358 0 | 69 97 | 2233 5 | 2653 7 | 2399 8 | 90 67 | 2266 9 | 2774 6 | 2 26 | 0 76 | 2 00 | 5 00 | 0 58 | 1 03 | 0 29 | 4 57 |
| [illegible] | HOL 1 | 1 00 | [illegible] | [illegible] | 0 | 2399 9 | 96 76 | 2266 9 | 2774 6 | 2399 9 | 90 70 | 2266 9 | 2774 6 | 2 78 | 0 79 | 2 50 | 5 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | HOL 1 | 1 00 | 100 | 0 | 0 | 891 9 | 27 79 | 838 5 | 1012 1 | 891 9 | 27 79 | 838 5 | 1012 1 | 1 69 | 0 15 | 1 46 | 2 53 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | SHG | 1 00 | 100 | [illegible] | 0 | 891 9 | 27 79 | 838 5 | 1012 1 | 910 2 | 26 96 | 859 0 | 1030 3 | 1 46 | 0 10 | 1 31 | 2 00 | 0 13 | 0 03 | 0 09 | 0 29 |
| [illegible] | SHG | 1 00 | 100 | 0 | 0 | 891 9 | 27 79 | 838 5 | 1012 1 | 924 6 | 28 93 | 873 3 | 1074 0 | 1 69 | 0 15 | 1 46 | 2 53 | 0 13 | 0 03 | 0 09 | 0 29 |
| [illegible] | SHG | 1 00 | 100 | 0 | 0 | 910 [illegible] | 26 96 | 857 0 | 1030 3 | 910 2 | 26 96 | 859 0 | 1030 3 | 1 46 | 0 10 | 1 31 | 2 00 | 0 13 | 0 03 | 0 09 | 0 29 |
| [illegible] | SHG | 1 00 | 100 | 0 | 0 | 910 [illegible] | 26 96 | 859 0 | 1030 3 | 928 2 | 26 20 | 879 8 | 1047 3 | 1 46 | 0 10 | 1 31 | 2 00 | 0 13 | 0 03 | 0 09 | 0 29 |
| [illegible] | HOL 1 | 1 00 | 100 | 0 | 0 | 891 9 | 27 79 | 838 5 | 1012 1 | 927 0 | 26 14 | 877 9 | 1045 3 | 1 46 | 0 10 | 1 31 | 2 00 | 0 13 | 0 03 | 0 09 | 0 29 |
| [illegible] | SHG | 1 00 | 100 | 0 | 0 | 891 9 | 27 79 | 838 5 | 1012 1 | 927 1 | 26 15 | 878 0 | 1015 3 | 1 46 | 0 10 | 1 31 | 2 00 | 0 13 | 0 03 | 0 09 | 0 29 |
| [illegible] | HOL 1 | 1 00 | 100 | 0 | 0 | 928 6 | 27 54 | 879 8 | 1074 0 | 928 6 | 27 54 | 879 8 | 1074 0 | 1 70 | 0 19 | 1 46 | 3 07 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | HOL 1 | 1 00 | 300 | 0 | 0 | 1147 0 | 623 14 | 376 1 | 2075 1 | 1147 0 | 623 14 | 376 1 | 2075 1 | 2 71 | 1 60 | 1 10 | 5 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | SHG | 1 00 | 300 | 0 | 0 | 1147 0 | 623 14 | 376 1 | 2075 1 | 1243 4 | 651 81 | 428 1 | 2197 6 | 3 21 | 1 59 | 1 10 | 5 00 | 1 80 | 1 85 | 0 02 | 4 57 |
| [illegible] | SHG | [illegible] | 300 | 0 | 0 | 1147 0 | 623 14 | 376 1 | 2075 1 | 1175 9 | 637 79 | 403 7 | 2137 1 | 3 18 | 1 60 | 1 07 | 5 00 | 1 78 | 1 83 | 0 02 | 4 57 |
| [illegible] | SHG | 1 00 | 300 | 0 | 0 | 1175 9 | 637 79 | 403 7 | 2137 1 | 1196 8 | 636 31 | 403 7 | 2137 1 | 3 25 | 1 62 | 1 07 | 5 00 | 1 78 | 1 77 | 0 02 | 4 57 |
| [illegible] | HOL 1 | [illegible] | [illegible] | 0 | 0 | 1147 0 | 623 14 | 376 1 | 2075 1 | 1241 5 | 646 89 | 430 7 | 2194 2 | 3 13 | 1 59 | 1 07 | 5 00 | 1 70 | 1 76 | 0 02 | 4 57 |
| [illegible] | SHG | 1 00 | 300 | 0 | 0 | 1196 8 | 636 31 | 403 7 | 2137 1 | 1247 0 | 650 34 | 431 2 | 2196 9 | 3 26 | 1 63 | 1 07 | 5 00 | 1 91 | 1 93 | 0 02 | 4 57 |
| [illegible] | SHG | 1 00 | 300 | 0 | 0 | 1147 0 | 623 14 | 376 1 | 2075 1 | 1244 1 | 650 07 | 429 1 | 2193 6 | 3 22 | 1 62 | 1 07 | 5 00 | 1 80 | 1 84 | 0 02 | 4 57 |
| [illegible] | HOL 1 | [illegible] | 300 | 0 | 0 | 1247 9 | 651 15 | 431 2 | 2197 6 | 1247 9 | 651 15 | 431 2 | 2197 6 | 2 90 | 1 49 | 1 10 | 5 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | HOL 1 | [illegible] | [illegible] | 0 | 0 | 1115 0 | 467 77 | 614 1 | 1726 1 | 1115 0 | 467 77 | 614 1 | 1726 1 | 1 88 | 0 63 | 1 18 | 2 50 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | SHG | [illegible] | [illegible] | 0 | 0 | 1115 0 | 467 77 | 614 1 | 1726 1 | 1136 2 | 464 60 | 638 6 | 1743 3 | 1 69 | 0 53 | 1 12 | 2 45 | 0 22 | 0 17 | 0 03 | 0 50 |
| [illegible] | SHG | [illegible] | [illegible] | [illegible] | [illegible] | 1115 0 | 467 77 | 614 1 | 1726 1 | 1196 2 | 506 70 | 660 2 | 1845 9 | 2 38 | 1 13 | 1 18 | 3 50 | 0 52 | 0 48 | 0 03 | 1 00 |
| [illegible] | HOL 1 | [illegible] | [illegible] | [illegible] | [illegible] | 1115 0 | 467 77 | 614 1 | 1726 1 | 1155 7 | 461 47 | 664 0 | 1760 8 | 1 66 | 0 50 | 1 12 | 2 38 | 0 21 | 0 16 | 0 03 | 0 47 |
| [illegible] | SHG | [illegible] | [illegible] | [illegible] | [illegible] | 1135 [illegible] | 464 60 | 638 6 | 1743 3 | 1177 0 | 458 42 | 688 5 | 1777 7 | 1 69 | 0 52 | 1 12 | 2 44 | 0 22 | 0 17 | 0 03 | 0 49 |
| [illegible] | SHG | [illegible] | [illegible] | [illegible] | 0 | 1115 0 | 467 77 | 614 1 | 1726 1 | 1155 9 | 461 69 | 664 3 | 1759 6 | 1 72 | 0 55 | 1 12 | 2 50 | 0 23 | 0 18 | 0 03 | 0 52 |
| [illegible] | HOL 1 | [illegible] | [illegible] | [illegible] | [illegible] | 1210 7 | 492 18 | 688 5 | 1845 9 | 1210 7 | 492 18 | 688 5 | 1845 9 | 1 90 | 0 60 | 1 23 | 2 50 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | HOL 1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] 88 | 534 5 | 1424 3 | 927 2 | 355 58 | 534 5 | 1424 3 | 1 99 | 0 97 | 1 13 | 5 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| [illegible] | SHG | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] 88 | 534 5 | 1424 3 | 955 9 | 364 06 | 534 5 | 1443 0 | 1 57 | 0 44 | 1 09 | 2 13 | 0 19 | 0 18 | 0 03 | 0 75 |
| [illegible] | SHG | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] 88 | 534 5 | 1424 3 | 1009 0 | 392 86 | 583 6 | 1545 9 | 2 43 | 1 28 | 1 13 | 5 00 | 0 71 | 1 01 | 0 03 | 4 57 |
| [illegible] | SHG | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] 9 | [illegible] 06 | 534 5 | 1443 0 | 957 2 | 359 99 | 560 5 | 1461 7 | 1 57 | 0 44 | 1 09 | 2 15 | 0 19 | 0 19 | 0 03 | 0 76 |
| [illegible] | HOL 1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] 88 | 534 5 | 1424 3 | 968 5 | 347 36 | 587 1 | 1458 3 | 1 57 | 0 44 | 1 09 | 2 08 | 0 19 | 0 1[illegible] | [illegible] | 0 7[illegible] |
| [illegible] | SHG | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] 99 | 560 5 | 1461 7 | 978 5 | 355 6[illegible] | 587 2 | 1479 5 | 1 57 | 0 44 | 1 09 | 2 14 | 0 19 | 0 1[illegible] | [illegible] | 0 7[illegible] |
| [illegible] | SHG | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] 38 | 538 5 | 1424 3 | 968 6 | 347 50 | 586 7 | 1458 8 | 1 58 | 0 45 | 1 09 | 2 16 | 0 19 | 0 1[illegible] | [illegible] | 0 76 |
| [illegible] | HOL 1 | [illegible] | [illegible] | [illegible] | [illegible] | 1012 6 | 389 98 | 587 2 | 1545 9 | 1012 6 | 389 [illegible] | [illegible] | 154[illegible] | [illegible] | [illegible] | [illegible] | 2 50 | 0 00 | 0 0[illegible] | [illegible] | 0 00 |
| [illegible] | HOL 1 | [illegible] | [illegible] | [illegible] | [illegible] | 97[illegible] 4 | 67[illegible] 56 | 96 8 | 2197 6 | 977 4 | 679 [illegible] | [illegible] | [illegible] | [illegible] 20 | 0 7[illegible] | 1 02 | 5 00 | 0 00 | [illegible] | [illegible] | 0 00 |
| [illegible] | SHG | [illegible] | [illegible] | [illegible] | [illegible] | 97[illegible] 1 | [illegible] 56 | 96 8 | 2197 6 | 1007 5 | 690 [illegible] | [illegible] | 2261 1 | [illegible] | [illegible] 24 | [illegible] 01 | 5 00 | 0 79 | [illegible] | [illegible] | 4 [illegible] |

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Figure 4-38 RTP Leg 6 Keyboard Report (2 of 3)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0 | [illegible] | 5 | [illegible] | [illegible] | [illegible] | 3 | 2261 | 1 | 1010 | 8 | 688 | 44 | 127 | 3 | 2261 | 1 | 2 | 63 | 1 | 31 | 1 | 01 | 5 | 00 | 0 | 87 | 1 | 67 | 0 | 00 | 4 | 57 |
| [illegible] | [illegible] | 1 | [illegible] | [illegible] | [illegible] | 0 | 1010 | 8 | [illegible] | 44 | [illegible] | 3 | 2261 | 1 | [illegible] | 3 | 700 | 51 | 127 | 3 | 2326 | 7 | 2 | 63 | 1 | 34 | 1 | 01 | 5 | 00 | 0 | 88 | 1 | 07 | 0 | 00 | 4 | 57 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0 | 972 | 4 | [illegible] | [illegible] | 96 | 8 | 2197 | 6 | 1097 | 7 | 721 | 34 | 183 | 6 | 2376 | 2 | 2 | 60 | 1 | 01 | 1 | 02 | 4 | 87 | 0 | 73 | 0 | 63 | 0 | 00 | 3 | 50 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0 | [illegible] | 3 | [illegible] | [illegible] | [illegible] | 3 | 2326 | 7 | 1038 | 2 | 698 | 69 | 157 | 3 | 2326 | 7 | 2 | 64 | 1 | 35 | 1 | 01 | 5 | 00 | 0 | 96 | 1 | 21 | 0 | 00 | 4 | 57 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0 | [illegible] | 2 | [illegible] | [illegible] | 157 | 3 | 2326 | 7 | 1044 | 1 | 691 | 54 | 187 | 4 | 2326 | 7 | 2 | 66 | 1 | 37 | 1 | 01 | 5 | 00 | 0 | 97 | 1 | 22 | 0 | 00 | 4 | 57 |
| [illegible] | MULT | [illegible] | [illegible] | [illegible] | [illegible] | 0 | 972 | 4 | 677 | 56 | 96 | 8 | 2197 | 6 | 1068 | 4 | 710 | 30 | 185 | 5 | 2377 | 0 | 2 | 48 | 1 | 20 | 1 | 01 | 5 | 00 | 0 | 75 | 0 | 89 | 0 | 00 | 4 | 57 |
| [illegible] | STBS | 1 | [illegible] | [illegible] | [illegible] | 0 | 972 | 4 | 677 | 56 | 96 | 8 | 2197 | 6 | 1078 | 2 | 713 | 82 | 164 | 3 | 2380 | 0 | 2 | 57 | 1 | 27 | 1 | 01 | 5 | 00 | 0 | 80 | 0 | 72 | 0 | 00 | 4 | 57 |
| [illegible] | MULT | 1 | [illegible] | [illegible] | [illegible] | 0 | 1099 | 3 | 723 | 64 | 187 | 4 | 2300 | 0 | 1099 | 3 | 723 | 64 | 187 | 4 | 2380 | 0 | 2 | 64 | 1 | 37 | 1 | 02 | 5 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| [illegible] | MULT | 1 | [illegible] | 100 | 0 | 0 | 0 | 0 | 0 | 00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 00 | 0 | 0 | 0 | 0 | 1 | 00 | 0 | 00 | 1 | 00 | 1 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| [illegible] | MULT | 1 | [illegible] | [illegible] | [illegible] | 0 | 0 | 0 | 0 | 00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 00 | 0 | 0 | 0 | 0 | 1 | 00 | 0 | 00 | 1 | 00 | 1 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| [illegible] | MULT | 1 | [illegible] | [illegible] | 0 | 0 | 0 | 0 | 0 | 00 | 0 | 0 | 0 | 0 | 30 | 9 | 1 | 03 | 28 | 1 | 32 | 6 | 1 | 00 | 0 | 00 | 1 | 00 | 1 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| [illegible] | MULT | 1 | [illegible] | [illegible] | [illegible] | 0 | 31 | 5 | 3 | 14 | 28 | 1 | 52 | 3 | 42 | 7 | 6 | 18 | 30 | 7 | 74 | 7 | 1 | 00 | 0 | 00 | 1 | 00 | 1 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| [illegible] | MULT | 1 | [illegible] | [illegible] | 0 | 0 | 42 | 8 | 6 | 10 | 30 | 7 | 74 | 7 | 53 | 2 | 7 | 46 | 35 | 7 | 90 | 3 | 1 | 00 | 0 | 00 | 1 | 00 | 1 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| [illegible] | MULT | 1 | [illegible] | 100 | 0 | 0 | 53 | 2 | 7 | 46 | 35 | 7 | 90 | 3 | 110 | 7 | 6 | 87 | 94 | 9 | 144 | 7 | 1 | 03 | 0 | 01 | 1 | 01 | 1 | 06 | 0 | 01 | 0 | 00 | 0 | 00 | 0 | 01 |
| [illegible] | MULT | 1 | [illegible] | [illegible] | 0 | 0 | 53 | 2 | 7 | 46 | 35 | 7 | 90 | 3 | 63 | 0 | 8 | 36 | 42 | 4 | 102 | 2 | 1 | 02 | 0 | 00 | 1 | 01 | 1 | 04 | 0 | 01 | 0 | 00 | 0 | 00 | 0 | 01 |
| [illegible] | MULT | 1 | [illegible] | [illegible] | 14 | 0 | 64 | 3 | 9 | 30 | 42 | 4 | 102 | 2 | 74 | 9 | 11 | 28 | 51 | 5 | 106 | 3 | 1 | 02 | 0 | 00 | 1 | 01 | 1 | 04 | 0 | 01 | 0 | 00 | 0 | 00 | 0 | 01 |
| [illegible] | MULT | 1 | [illegible] | [illegible] | 0 | 0 | 75 | 1 | 11 | 32 | 51 | 5 | 106 | 3 | 84 | 2 | 11 | 79 | 61 | 0 | 118 | 8 | 1 | 02 | 0 | 00 | 1 | 01 | 1 | 04 | 0 | 01 | 0 | 00 | 0 | 00 | 0 | 01 |
| [illegible] | MULT | 1 | [illegible] | 100 | 0 | 0 | 84 | 2 | 11 | 79 | 61 | 0 | 118 | 8 | 96 | 4 | 11 | 82 | 69 | 5 | 129 | 4 | 1 | 02 | 0 | 00 | 1 | 01 | 1 | 04 | 0 | 01 | 0 | 00 | 0 | 00 | 0 | 01 |
| [illegible] | MULT | 1 | 00 | 100 | 0 | 0 | 111 | 2 | 7 | 11 | 95 | 7 | 144 | 7 | 111 | 2 | 7 | 11 | 95 | 7 | 144 | 7 | 1 | 03 | 0 | 01 | 1 | 01 | 1 | 06 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| [illegible] | MULT | 1 | 00 | 200 | 0 | 0 | 2050 | 5 | 356 | 75 | 1639 | 7 | 2774 | 6 | 2050 | 5 | 356 | 75 | 1639 | 7 | 2774 | 6 | 3 | 19 | 0 | 97 | 2 | 50 | 5 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| [illegible] | MULT | 1 | 00 | 200 | 0 | 0 | 2050 | 5 | 356 | 75 | 1639 | 7 | 2774 | 6 | 2067 | 1 | 340 | 41 | 1672 | 9 | 2774 | 6 | 3 | 25 | 1 | 32 | 2 | 00 | 5 | 00 | 1 | 19 | 1 | 24 | 0 | 29 | 4 | 57 |
| [illegible] | MULT | 1 | 00 | 250 | 0 | 0 | 2067 | 1 | 340 | 41 | 1672 | 9 | 2774 | 6 | 2076 | 6 | 345 | 45 | 1677 | 2 | 2782 | 0 | 3 | 13 | 1 | 24 | 2 | 00 | 5 | 00 | 1 | 11 | 1 | 22 | 0 | 29 | 4 | 57 |
| [illegible] | MULT | 1 | 00 | 200 | 0 | 0 | 2076 | 6 | 345 | 45 | 1677 | 2 | 2782 | 0 | 2076 | 6 | 345 | 45 | 1677 | 2 | 2782 | 0 | 3 | 20 | 1 | 29 | 2 | 00 | 5 | 00 | 1 | 17 | 1 | 24 | 0 | 29 | 4 | 57 |
| [illegible] | MULT | 1 | 00 | 200 | 0 | 0 | 2076 | 6 | 345 | 45 | 1677 | 2 | 2782 | 0 | 2076 | 6 | 345 | 45 | 1677 | 2 | 2782 | 0 | 3 | 20 | 1 | 29 | 2 | 00 | 5 | 00 | 1 | 17 | 1 | 24 | 0 | 29 | 4 | 57 |
| [illegible] | MULT | 1 | 00 | 200 | 0 | 0 | 2076 | 6 | 345 | 45 | 1677 | 2 | 2782 | 0 | 2076 | 6 | 345 | 45 | 1677 | 2 | 2782 | 0 | 3 | 16 | 0 | 97 | 2 | 50 | 5 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 813 | 5 | 604 | 56 | 210 | 0 | 1895 | 9 | 813 | 5 | 604 | 56 | 210 | 0 | 1895 | 9 | 2 | 03 | 0 | 97 | 1 | 04 | 5 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 813 | 5 | 604 | 56 | 210 | 0 | 1895 | 9 | 855 | 5 | 615 | 56 | 239 | 8 | 1953 | 4 | 2 | 23 | 1 | 17 | 1 | 03 | 5 | 00 | 0 | 60 | 0 | 66 | 0 | 01 | 4 | 34 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 855 | 5 | 615 | 56 | 239 | 8 | 1953 | 4 | 898 | 6 | 628 | 07 | 271 | 3 | 2020 | 5 | 2 | 39 | 1 | 35 | 1 | 03 | 5 | 00 | 0 | 70 | 0 | 79 | 0 | 01 | 4 | 57 |
| [illegible] | STBS | 1 | 00 | 400 | 0 | 0 | 855 | 5 | 615 | 56 | 239 | 8 | 1953 | 4 | 939 | 4 | 647 | 54 | 293 | 6 | 2069 | 4 | 2 | 68 | 1 | 61 | 1 | 07 | 5 | 00 | 0 | 84 | 0 | 98 | 0 | 01 | 4 | 57 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 855 | 5 | 615 | 56 | 237 | 8 | 1953 | 4 | 920 | 5 | 640 | 86 | 297 | 0 | 2075 | 1 | 1 | 92 | 0 | 99 | 1 | 03 | 3 | 50 | 0 | 38 | 0 | 41 | 0 | 01 | 1 | 71 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 898 | 6 | 628 | 07 | 271 | 3 | 2020 | 5 | 898 | 6 | 628 | 07 | 271 | 3 | 2020 | 5 | 2 | 60 | 1 | 58 | 1 | 05 | 5 | 00 | 1 | 00 | 1 | 25 | 0 | 01 | 4 | 57 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 898 | 6 | 628 | 07 | 271 | 3 | 2020 | 5 | 898 | 6 | 628 | 07 | 271 | 3 | 2020 | 5 | 2 | 60 | 1 | 58 | 1 | 05 | 5 | 00 | 1 | 00 | 1 | 25 | 0 | 01 | 4 | 57 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 942 | 3 | 645 | 79 | 297 | 0 | 2075 | 1 | 942 | 3 | 645 | 79 | 297 | 0 | 2075 | 1 | 2 | 50 | 1 | 58 | 1 | 07 | 5 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 1173 | 5 | 671 | 75 | 446 | 7 | 2380 | 0 | 1173 | 5 | 671 | 75 | 446 | 7 | 2380 | 0 | 2 | 95 | 1 | 65 | 1 | 12 | 5 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| [illegible] | MULT | 1 | 00 | [illegible] | 98 | 0 | 1377 | 2 | 746 | 02 | 446 | 7 | 2437 | 7 | 1392 | 5 | 755 | 56 | 448 | 0 | 2472 | 4 | 2 | 95 | 1 | 66 | 1 | 08 | 5 | 00 | 1 | 36 | 1 | 38 | 0 | 02 | 4 | 57 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 1192 | 4 | 690 | 48 | 448 | 0 | 2472 | 4 | 1223 | 0 | 706 | 14 | 475 | 3 | 2530 | 3 | 2 | 49 | 1 | 50 | 1 | 08 | 5 | 00 | 1 | 30 | 1 | 76 | 0 | 02 | 4 | 57 |
| [illegible] | MULT | 1 | 00 | 400 | 88 | 0 | 1424 | 2 | 773 | 76 | 475 | 3 | 2530 | 3 | 1424 | 2 | 773 | 76 | 475 | 3 | 2530 | 3 | 2 | 93 | 1 | 67 | 1 | 08 | 5 | 00 | 1 | 35 | 1 | 39 | 0 | 02 | 4 | 57 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 1223 | 0 | 706 | 14 | 475 | 3 | 2530 | 3 | 1223 | 0 | 706 | 14 | 475 | 3 | 2530 | 3 | 2 | 48 | 1 | 50 | 1 | 08 | 5 | 00 | 1 | 36 | 1 | 87 | 0 | 02 | 4 | 57 |
| [illegible] | MULT | 1 | 00 | 400 | 0 | 0 | 1223 | 0 | 706 | 14 | 475 | 3 | 2530 | 3 | 1223 | 0 | 706 | 14 | 475 | 3 | 2530 | 3 | 2 | 48 | 1 | 50 | 1 | 08 | 5 | 00 | 0 | 98 | 1 | 24 | 0 | 02 | 4 | 57 |

Figure 4-38 RTP Leg 6 Keyboard Report (3 of 3)

4.1.3.3.2 Dynamic Test/Activate Discrete Malfunction (Cont'd)

it should be remembered that this task was performed four times per mission. Thus, it failed 98 times out of 500 releases. The mean stress values on the operators were:

Operator 1 - 2.09
Operator 2 - 1.98
Operator 3 - 1.98
Operator 4 - 2.09
Operator 5 - 2.40
Operator 6 - 1.77
Operator 7 - 1.77

The time of completion, in seconds, was 2432.6/mean, 2290.8/minimum, 2830.1/maximum, and 100.3/standard.

The parameter set for task 118 was then changed to the parameters obtained from the light pen/malfunction TAM. The probability of successfully completing this task was set at 0.95 and that of failure at 0.05.

The results obtained from running the sixth leg of the RTP with these data (Figure 4-39) were 97/100 successful missions. The average time of completion, in seconds, was 2400.2/mean, 2273.7/minimum, 2713.0/maximum, and 2.28/standard.

The average stress values on the operators were:

Operator 1 - 2.04
Operator 2 - 1.91
Operator 3 - 1.91
Operator 4 - 2.03
Operator 5 - 2.38
Operator 6 - 1.77
Operator 7 - 1.77

Task 118 failed 100 times in the 500 times it was released.

The parameter set for task 118 was then changed to the parameters obtained from the push button/malfunction TAM. A probability of 0.99 was assigned to the successful branch of task 118, with the failure branch having a probability of 0.01.

The results obtained from running the RTP with these data (Figure 4-40) were 96/100 successful missions. Task 118 failed 97 times out of 497 releases. The time of completion, in seconds, was 2397.7/mean, 2304.4/minimum, 2692.2/maximum, and 63.3/standard.

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK NO. | [illegible] | [illegible] PSS | COUNTERS REL | FAIL | SKIP | TIME TASK REALIZED MEAN | STD | MIN | MAX | TIME TASK COMPLETED MEAN | STD | MIN | MAX | TASK STRESS MEAN | STD | MIN | MAX | TASK COHESIVENESS MEAN | STD | MIN | MAX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MULT | 1 00 | 117 | 17 | 0 | [illegible] | 8 35 | 96 8 | 138 7 | 127 1 | 15 68 | 96 8 | 172 3 | 1 02 | 0 00 | 1 01 | 1 03 | 0 01 | 0 00 | 0.00 | 0 01 |
| 2 | MULT | 1 00 | 102 | 2 | 0 | 218 0 | 15 61 | 187 4 | 257 3 | 243 5 | 15 70 | 210 0 | 285 3 | 1 03 | 0 01 | 1 01 | 1 06 | 0 01 | 0 00 | 0 00 | 0 02 |
| 3 | MULT | 1 00 | 100 | 0 | 0 | 243 3 | 15 78 | 210 0 | 285 3 | 243 3 | 15 79 | 210 0 | 285 3 | 1 03 | 0 01 | 1 01 | 1 06 | 0 01 | 0 00 | 0 00 | 0 02 |
| 4 | MULT | 1 00 | 100 | 0 | 0 | 327 6 | 14 42 | 297 0 | 366 0 | 327 6 | 14 42 | 297 0 | 366 0 | 1 07 | 0 01 | 1 05 | 1 10 | 0 02 | 0 00 | 0 01 | 0 03 |
| 5 | MULT | 1 00 | 121 | 21 | 0 | 461 4 | 13 97 | 431 2 | 498 5 | 476 5 | 14 31 | 444 1 | 520 0 | 1 09 | 0 01 | 1 07 | 1 12 | 0 03 | 0 00 | 0 02 | 0.04 |
| 6 | MULT | 1 00 | 100 | 0 | 0 | 513 8 | 13 97 | 477 2 | 549 8 | 522 4 | 14 55 | 486 2 | 563 0 | 1 11 | 0 01 | 1 08 | 1 16 | 0 03 | 0 00 | 0 02 | 0 04 |
| 7 | MULT | 1 00 | 129 | 29 | 0 | [illegible] 3 | 15 43 | 569 0 | 672 0 | 639 7 | 16 53 | 601 7 | 688 6 | 1 13 | 0 02 | 1 09 | 1 18 | 0 04 | 0 00 | 0 03 | 0 05 |
| 8 | MULT | 1 00 | 101 | 1 | 0 | 629 6 | 16 93 | 610 5 | 688 6 | 646 0 | 16 96 | 618 1 | 696 1 | 1 13 | 0 02 | 1 09 | 1 18 | 0 04 | 0 00 | 0 03 | 0.05 |
| 9 | MULT | 1 00 | 119 | 19 | 0 | 719 4 | 14 96 | 694 0 | 761 6 | 731 5 | 15 15 | 702 4 | 770 6 | 1 20 | 0 02 | 1 16 | 1 28 | 0 06 | 0 01 | 0 05 | 0 08 |
| 10 | MULT | 1 00 | 100 | 0 | 0 | 732 2 | 15 47 | 702 4 | 773 6 | 738 1 | 15 30 | 708 9 | 784 0 | 1 20 | 0 02 | 1 16 | 1 28 | 0 06 | 0 01 | 0 05 | 0 08 |
| 11 | MULT | 1 00 | 110 | 10 | 0 | 1231 7 | 25 66 | 1178 3 | 1311 9 | 1241 2 | 25 96 | 1187 2 | 1319 2 | 2 00 | 0 00 | 2 00 | 2 00 | 0.67 | 0 19 | 0 29 | 0 76 |
| 12 | MULT | 1 00 | 105 | 5 | 0 | 1244 3 | 27 35 | 1209 6 | 1340 9 | 1275 1 | 27 49 | 1217.9 | 1352 2 | 2 00 | 0 00 | 2 00 | 2 00 | 0 59 | 0 23 | 0 29 | 0 76 |
| 13 | MULT | 1 00 | 101 | 1 | 0 | 1733 3 | 28 81 | 1675 7 | 1813 0 | 1747.8 | 28.81 | 1688.7 | 1828.8 | 2 00 | 0 00 | 2 00 | 2 00 | 0 29 | 0.00 | 0 29 | 0 29 |
| 14 | MULT | 1 00 | 103 | 3 | 0 | 2327 2 | 48 36 | 2215 4 | 2473 7 | 2335 0 | 49 95 | 2215 9 | 2528 6 | 2 07 | 0 [illegible] | 2 00 | 5 00 | 0 49 | 0.27 | 0 32 | 2 65 |
| 15 | MULT | 1 00 | 100 | 0 | 0 | 2385 3 | 58 15 | 2259 5 | 2661 3 | 2400 2 | 62 28 | 2273 7 | 2713 0 | 2 09 | 0 51 | 2 00 | 5.00 | 0 47 | 0 74 | 0 29 | 4 57 |
| 20 | MULT | 1 00 | 100 | 0 | 0 | 2335 6 | 50 46 | 2215 9 | 2528 6 | 2335 6 | 50 46 | 2215 9 | 2528 6 | 2 53 | 0 25 | 2.50 | 5 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| 21 | SING | 1 00 | 100 | 0 | 0 | 2335 6 | 50 46 | 2215 9 | 2528 6 | 2335 6 | 50 46 | 2215.9 | 2528 6 | 2 04 | 0 31 | 2 00 | 5.00 | 0.33 | 0 43 | 0 29 | 4 57 |
| 22 | SING | 1 00 | 100 | 0 | 0 | 2335 6 | 50 46 | 2215 9 | 2528 6 | 2353 5 | 52 65 | 2234 1 | 2586 2 | 2 04 | 0 31 | 2 00 | 5 00 | 0 33 | 0 43 | 0 29 | 4 57 |
| 23 | MULT | 1 00 | 100 | 0 | 0 | 2335 6 | 50 46 | 2215 9 | 2528.6 | 2370 9 | 57 76 | 2249 3 | 2648 5 | 2 06 | 0 34 | 2 00 | 5.00 | 0 34 | 0 43 | 0 29 | 4 57 |
| 24 | SING | 1 00 | 100 | 0 | 0 | 2335 6 | 50 46 | 2215 9 | 2528 6 | 2370 9 | 57 79 | 2249 1 | 2650 4 | 2 06 | 0.34 | 2 00 | 5 00 | 0 34 | 0 43 | 0 29 | 4.57 |
| 25 | MULT | 1 00 | 100 | 0 | 0 | 2371 0 | 57 84 | 2249 3 | 2650.4 | 2371.0 | 57 84 | 2249.3 | 2650 4 | 2 58 | 0 43 | 2.50 | 5.00 | 0.00 | 0.00 | 0 00 | 0.00 |
| 26 | MULT | 1 00 | 100 | 0 | 0 | 887 6 | 25 82 | 838 9 | 971 2 | 887 6 | 25.82 | 838 9 | 971 2 | 1 67 | 0 13 | 1 46 | 2.16 | 0 00 | 0 00 | 0 00 | 0 00 |
| 27 | SING | 1 00 | 100 | 0 | 0 | 887 6 | 25 82 | 838 9 | 971 2 | 906 1 | 24 89 | 859.3 | 987 6 | 1 44 | 0 08 | 1 31 | 1 77 | 0 13 | 0.02 | 0 09 | 0 22 |
| 28 | SING | 1 00 | 100 | 0 | 0 | 887 6 | 25 82 | 838 9 | 971 2 | 920 1 | 25 53 | 873 7 | 1005 5 | 1 67 | 0.13 | 1 46 | 2 16 | 0.13 | 0.02 | 0 09 | 0 22 |
| 29 | SING | 1 00 | 100 | 0 | 0 | 906 1 | 24 89 | 859 3 | 987 6 | 906 1 | 24.89 | 859 3 | 987 6 | 1 44 | 0 08 | 1.31 | 1 77 | 0 13 | 0 02 | 0 09 | 0 22 |
| 30 | SING | 1 00 | 100 | 0 | 0 | 906 1 | 24 89 | 859 3 | 987 6 | 924 3 | 23 97 | 880 1 | 1004 6 | 1 44 | 0 08 | 1 31 | 1 77 | 0 13 | 0 02 | 0 09 | 0 22 |
| 31 | MULT | 1 00 | 100 | 0 | 0 | 887 6 | 25 82 | 838 9 | 971 2 | 923 1 | 24 03 | 878 2 | 1003 3 | 1 44 | 0 08 | 1 31 | 1 77 | 0.13 | 0.02 | 0 09 | 0 22 |
| 32 | SING | 1 00 | 100 | 0 | 0 | 887 6 | 25 82 | 838 9 | 971 2 | 923 1 | 24 06 | 878.3 | 1003 2 | 1 44 | 0 08 | 1 31 | 1 77 | 0.13 | 0 02 | 0 09 | 0 22 |
| 33 | MULT | 1 00 | 100 | 0 | 0 | 924 3 | 24 02 | 880.1 | 1005 5 | 924.3 | 24 02 | 880.1 | 1005.5 | 1 67 | 0.13 | 1 46 | 2.21 | 0.00 | 0 00 | 0.00 | 0 00 |
| 34 | MULT | 1 00 | 300 | 0 | 0 | 1143 1 | 620 63 | 376 1 | 2006 8 | 1143 1 | 620.63 | 376 1 | 2006.8 | 2 90 | 1 60 | 1 10 | 5 00 | 0.00 | 0 00 | 0 00 | 0 00 |
| 35 | SING | 1 00 | 300 | 0 | 0 | 1143 1 | 620 63 | 376 1 | 2006 8 | 1239 5 | 649 21 | 428.2 | 2128.6 | 3 21 | 1 59 | 1 10 | 5 00 | 1 76 | 1 81 | 0 02 | 4 57 |
| 36 | SING | 1 00 | 300 | 0 | 0 | 1143 1 | 620 63 | 376 1 | 2006 8 | 1171 6 | 634.86 | 403.7 | 2069 9 | 3 16 | 1 60 | 1 07 | 5 00 | 1 73 | 1 79 | 0 02 | 4 57 |
| 37 | SING | 1 00 | 300 | 0 | 0 | 1171 8 | 634 86 | 403 7 | 2069 9 | 1192 7 | 633 36 | 403 7 | 2069 9 | 3 22 | 1 61 | 1 07 | 5.00 | 1 73 | 1 73 | 0 02 | 4 57 |
| 38 | MULT | 1 00 | 300 | 0 | 0 | 1143 1 | 620 63 | 376 1 | 2006.8 | 1236 8 | 643 20 | 430 8 | 2129.2 | 3 11 | 1 58 | 1 07 | 5 00 | 1.65 | 1 72 | 0 02 | 4 57 |
| 39 | SING | 1 00 | 300 | 0 | 0 | 1172 7 | 633 36 | 403 7 | 2069 9 | 1242 8 | 647 23 | 431 2 | 2127 4 | 3.24 | 1 62 | 1 07 | 5 00 | 1 89 | 1.94 | 0.02 | 4 57 |
| 40 | SING | 1 00 | 300 | 0 | 0 | 1143 1 | 620 63 | 376 1 | 2006 8 | 1239 8 | 647 02 | 429 1 | 2129 6 | 3 20 | 1 61 | 1 07 | 5.00 | 1 76 | 1 81 | 0 02 | 4 57 |
| 41 | MULT | 1 00 | 300 | 0 | 0 | 1243.0 | 648.19 | 431.2 | 2129.6 | 1243 8 | 648.19 | 431.2 | 2129.6 | 2 91 | 1 50 | 1.10 | 5.00 | 0.00 | 0.00 | 0 00 | 0 00 |
| 42 | MULT | 1 00 | 200 | 0 | 0 | 1110 5 | 466 16 | 618 1 | 1655 6 | 1110 5 | 466 16 | 618 1 | 1655 6 | 1 87 | 0 63 | 1 19 | 2.50 | 0.00 | 0.00 | 0 00 | 0 00 |
| 43 | SING | 1 00 | 200 | 0 | 0 | 1110 5 | 466 16 | 618 1 | 1655 6 | 1131 8 | 462 94 | 644 0 | 1673 7 | 1 68 | 0 52 | 1 13 | 2 31 | 0 21 | 0 17 | 0 04 | 0.44 |
| 44 | SING | 1 00 | 200 | 0 | 0 | 1110 5 | 466 16 | 618 1 | 1655 6 | 1191 8 | 504 91 | 663.7 | 1775 0 | 2 37 | 1 13 | 1 19 | 3 50 | 0 52 | 0.48 | 0 04 | 1 00 |
| 45 | MULT | 1 00 | 200 | 0 | 0 | 1110 5 | 466 16 | 618 1 | 1655 6 | 1151 3 | 459 70 | 667 5 | 1690 5 | 1 65 | 0 49 | 1 13 | 2 25 | 0.20 | 0 15 | 0 04 | 0.41 |
| 46 | SING | 1 00 | 200 | 0 | 0 | 1131 8 | 462 94 | 644 0 | 1673 7 | 1172 7 | 456 58 | 694 0 | 1709 8 | 1 68 | 0 52 | 1 13 | 2 30 | 0 21 | 0.17 | 0 04 | 0 43 |
| 47 | SING | 1 00 | 200 | 0 | 0 | 1110 5 | 466 16 | 618 1 | 1655 6 | 1151 5 | 459 94 | 667 7 | 1690.3 | 1 70 | 0 54 | 1 13 | 2 36 | 0 22 | 0 18 | 0 04 | 0 46 |
| 48 | MULT | 1 00 | 200 | 0 | 0 | 1206 4 | 490 33 | 694 0 | 1775 0 | 1206 4 | 490 33 | 694 0 | 1775 0 | 1 90 | 0 60 | 1 24 | 2 50 | 0 00 | 0 00 | 0 00 | 0 00 |
| 49 | MULT | 1 00 | 200 | 0 | 0 | 923 1 | 353 53 | 536 5 | 1352 2 | 923 1 | 353.53 | 536 5 | 1352 2 | 2 05 | 1 07 | 1.14 | 5.00 | 0 00 | 0 00 | 0 00 | 0.00 |
| 50 | SING | 1 00 | 200 | 0 | 0 | 923 1 | 353 53 | 536 5 | 1352 2 | 931 8 | 362 19 | 536 5 | 1369 8 | 1 57 | 0 44 | 1 09 | 2 05 | 0 20 | 0 20 | 0 03 | 0 76 |
| 51 | SING | 1 00 | 200 | 0 | 0 | 923 1 | 353 53 | 536 5 | 1352 2 | 1005.7 | 390 87 | 585 3 | 1472 4 | 2 47 | 1 33 | 1 14 | 5.00 | 0 80 | 1 19 | 0 03 | 4.57 |
| 52 | SING | 1 00 | 200 | 0 | 0 | 931 8 | 362 19 | 536 5 | 1369 8 | 953.1 | 358 05 | 562.4 | 1386 9 | 1 57 | 0 44 | 1 09 | 2 06 | 0 20 | 0.21 | 0 03 | 0 76 |
| 53 | MULT | 1 00 | 200 | 0 | 0 | 923 1 | 353 53 | 536 5 | 1352 2 | 964 5 | 345 41 | 588 8 | 1385 5 | 1 57 | 0 44 | 1.09 | 2 00 | 0 20 | 0 20 | 0 03 | 0 75 |
| 54 | SING | 1 00 | 200 | 0 | 0 | 953 1 | 358 05 | 562 4 | 1386 9 | 974 5 | 353 81 | 589 0 | 1404 8 | 1 57 | 0 44 | 1 09 | 2 05 | 0 20 | 0 20 | 0 03 | 0.75 |
| 55 | SING | 1 00 | 200 | 0 | 0 | 923 1 | 353 53 | 536 5 | 1352 2 | 964 5 | 345 50 | 588 5 | 1386 1 | 1 57 | 0 44 | 1 09 | 2 08 | 0 20 | 0 21 | 0 03 | 0 76 |
| 56 | MULT | 1 00 | 500 | 0 | 0 | 1008 7 | 387 75 | 589 0 | 1472 4 | 1008 7 | 387 [illegible] | [illegible] | 1472 4 | [illegible] | [illegible] | [illegible] | 2 50 | 0 00 | 0 00 | 0 00 | 0 00 |
| 57 | MULT | 1 00 | 500 | 0 | 0 | 961 5 | 677 17 | 96 8 | 2129 6 | 968 5 | 677 [illegible] | [illegible] | 2129 6 | 2 25 | 0 73 | 1 02 | 4 61 | 0 00 | 0 00 | 0 00 | 0 00 |
| 58 | SING | 1 00 | 500 | 0 | 0 | 968 5 | 677 17 | 96 8 | 2179 6 | 1002 7 | 687 [illegible] | [illegible] | 2192 4 | 2 [illegible] | [illegible] | [illegible] 01 | 5 00 | 0 76 | 0 87 | 0 00 | 3 73 |



Figure 4-39 RTP Leg 6 Light Pen Report (1 of 3)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | [illegible] | 7 | [illegible] | 88 | 127 | 4 | 2192 | 4 | 1006 | 0 | 605 | 65 | 127 | 4 | 2192 | 4 | 2 | 60 | 1 | 33 | 1 | 01 | 5 | 00 | 0 | 84 | 1 | 01 | 0 | 00 | 4 | 20 |
| 0 | [illegible] | 0 | [illegible] | 65 | 127 | 4 | 2192 | 4 | 1010 | 4 | 705 | 76 | 127 | 4 | 2252 | 9 | 2 | 61 | 1 | 32 | 1 | 01 | 5 | 00 | 0 | 81 | 1 | 01 | 0 | 00 | 4 | 26 |
| 0 | [illegible] | 5 | [illegible] | [illegible] | 96 | 8 | 2129 | 6 | 1021 | 5 | 722 | 07 | 183 | 7 | 2310 | 0 | 2 | 59 | 1 | 01 | 1 | 02 | 4 | 16 | 0 | 71 | 0 | 61 | 0 | 00 | 3 | 58 |
| 0 | 1018 | 4 | [illegible] | 76 | 127 | 4 | 2252 | 9 | 1033 | 3 | 695 | 06 | 157 | 4 | 2252 | 9 | 2 | 63 | 1 | 35 | 1 | 01 | 5 | 00 | 0 | 93 | 1 | 18 | 0 | 00 | 4 | 20 |
| 0 | 1011 | 4 | [illegible] | 66 | 157 | 4 | 2252 | 9 | 1039 | 2 | 688 | 69 | 187 | 4 | 2252 | 9 | 2 | 64 | 1 | 37 | 1 | 01 | 5 | 00 | 0 | 93 | 1 | 16 | 0 | 00 | 4 | 20 |
| 0 | 968 | 5 | 677 | 17 | 96 | 8 | 2129 | 6 | 1063 | 9 | 707 | 85 | 185 | 5 | 2313 | 2 | 2 | 45 | 1 | 18 | 1 | 01 | 5 | 00 | 0 | 72 | 0 | 84 | 0 | 00 | 3 | 56 |
| 0 | 968 | 5 | 677 | 17 | 96 | 8 | 2129 | 6 | 1073 | 3 | 711 | 15 | 184 | 4 | 2312 | 8 | 2 | 57 | 1 | 25 | 1 | 01 | 5 | 00 | 0 | 77 | 0 | 87 | 0 | 00 | 3 | 71 |
| 0 | 1095 | 0 | 721 | 28 | 187 | 4 | 2313 | 2 | 1095 | 0 | 721 | 28 | 187 | 4 | 2313 | 2 | 2 | 63 | 1 | 37 | 1 | 02 | 5 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| 0 | 0 | 0 | 0 | 00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 00 | 0 | 0 | 0 | 0 | 1 | 00 | 0 | 00 | 1 | 00 | 1 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| 0 | 0 | 0 | 0 | 00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 00 | 0 | 0 | 0 | 0 | 1 | 00 | 0 | 00 | 1 | 00 | 1 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| 0 | 0 | 0 | 0 | 00 | 0 | 0 | 0 | 0 | 30 | 7 | 1 | 01 | 28 | 1 | 32 | 6 | 1 | 00 | 0 | 00 | 1 | 00 | 1 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| 0 | 31 | 1 | 2 | 29 | 28 | 1 | 45 | 4 | 42 | 4 | 5 | 13 | 30 | 7 | 60 | 3 | 1 | 00 | 0 | 00 | 1 | 00 | 1 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| 0 | 42 | 0 | 4 | 94 | 30 | 7 | 60 | 3 | 52 | 7 | 6 | 70 | 35 | 7 | 69 | 3 | 1 | 00 | 0 | 00 | 1 | 00 | 1 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| 0 | 52 | 7 | 6 | 70 | 15 | 7 | 69 | 3 | 110 | 1 | 6 | 16 | 94 | 9 | 125 | 9 | 1 | 03 | 0 | 01 | 1 | 01 | 1 | 04 | 0 | 01 | 0 | 00 | 0 | 00 | 0 | 01 |
| 0 | 52 | 7 | 6 | 70 | 35 | 7 | 69 | 3 | 62 | 0 | 7 | 70 | 42 | 4 | 83 | 6 | 1 | 02 | 0 | 00 | 1 | 01 | 1 | 03 | 0 | 01 | 0 | 00 | 0 | 00 | 0 | 01 |
| 0 | 64 | 4 | 8 | 90 | 42 | 4 | 91 | 0 | 75 | 0 | 10 | 69 | 54 | 5 | 105 | 3 | 1 | 02 | 0 | 00 | 1 | 01 | 1 | 03 | 0 | 01 | 0 | 00 | 0 | 00 | 0 | 01 |
| 0 | 75 | 1 | 10 | 86 | 54 | 5 | 105 | 3 | 85 | 1 | 11 | 57 | 61 | 0 | 118 | 8 | 1 | 02 | 0 | 00 | 1 | 01 | 1 | 03 | 0 | 01 | 0 | 00 | 0 | 00 | 0 | 01 |
| 0 | 85 | 1 | 11 | 57 | 61 | 0 | 118 | 8 | 97 | 0 | 12 | 16 | 69 | 5 | 135 | 7 | 1 | 02 | 0 | 00 | 1 | 01 | 1 | 03 | 0 | 01 | 0 | 00 | 0 | 00 | 0 | 01 |
| 0 | 110 | 8 | 6 | 78 | 96 | 8 | 135 | 7 | 110 | 8 | 6 | 78 | 96 | 8 | 135 | 7 | 1 | 03 | 0 | 01 | 1 | 02 | 1 | 05 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| 0 | 2033 | 0 | 341 | 86 | 1638 | 2 | 2650 | 4 | 2033 | 0 | 341 | 86 | 1638 | 2 | 2650 | 4 | 3 | 04 | 0 | 85 | 2 | 50 | 5 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| 0 | 2033 | 0 | 341 | 86 | 1638 | 2 | 2650 | 4 | 2049 | 6 | 325 | 35 | 1671 | 3 | 2650 | 4 | 3 | 15 | 1 | 23 | 2 | 00 | 5 | 00 | 1 | 00 | 0 | 95 | 0 | 29 | 4 | 57 |
| 0 | 2049 | 6 | 325 | 35 | 1671 | 3 | 2650 | 4 | 2058 | 9 | 330 | 33 | 1675 | 7 | 2661 | 3 | 3 | 01 | 1 | 13 | 2 | 00 | 5 | 00 | 0 | 92 | 0 | 92 | 0 | 29 | 4 | 57 |
| 0 | 2058 | 9 | 330 | 33 | 1675 | 7 | 2661 | 3 | 2058 | 9 | 330 | 33 | 1675 | 7 | 2661 | 3 | 3 | 09 | 1 | 20 | 2 | 00 | 5 | 00 | 0 | 97 | 0 | 95 | 0 | 29 | 4 | 57 |
| 0 | 2058 | 9 | 330 | 33 | 1675 | 7 | 2661 | 3 | 2058 | 9 | 330 | 33 | 1675 | 7 | 2661 | 3 | 3 | 09 | 1 | 20 | 2 | 00 | 5 | 00 | 0 | 97 | 0 | 95 | 0 | 29 | 4 | 57 |
| 0 | 2058 | 9 | 330 | 33 | 1675 | 7 | 2661 | 3 | 2058 | 9 | 330 | 33 | 1675 | 7 | 2661 | 3 | 3 | 00 | 0 | 05 | 2 | 50 | 5 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| 0 | 810 | 6 | 602 | 24 | 210 | 0 | 1828 | 8 | 810 | 6 | 602 | 24 | 210 | 0 | 1828 | 8 | 2 | 02 | 0 | 96 | 1 | 04 | 4 | 42 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| 0 | 810 | 6 | 602 | 24 | 210 | 0 | 1828 | 8 | 852 | 4 | 613 | 01 | 239 | 8 | 1885 | 9 | 2 | 21 | 1 | 15 | 1 | 03 | 4 | 40 | 0 | 58 | 0 | 62 | 0 | 01 | 2 | 67 |
| 0 | 852 | 4 | 613 | 01 | 239 | 8 | 1885 | 9 | 895 | 4 | 625 | 22 | 271 | 3 | 1952 | 4 | 2 | 36 | 1 | 32 | 1 | 03 | 5 | 00 | 0 | 67 | 0 | 75 | 0 | 01 | 3 | 56 |
| 0 | 852 | 4 | 613 | 01 | 239 | 8 | 1885 | 9 | 936 | 4 | 644 | 94 | 293 | 7 | 2006 | 8 | 2 | 68 | 1 | 60 | 1 | 07 | 5 | 00 | 0 | 82 | 0 | 94 | 0 | 01 | 4 | 05 |
| 0 | 852 | 4 | 613 | 01 | 239 | 8 | 1885 | 9 | 917 | 3 | 638 | 25 | 297 | 0 | 2005 | 4 | 1 | 92 | 0 | 99 | 1 | 03 | 3 | 50 | 0 | 33 | 0 | 40 | 0 | 01 | 1 | 02 |
| 0 | 895 | 4 | 625 | 22 | 271 | 3 | 1952 | 4 | 895 | 4 | 625 | 22 | 271 | 3 | 1952 | 4 | 2 | 57 | 1 | 55 | 1 | 05 | 5 | 00 | 0 | 97 | 1 | 21 | 0 | 01 | 4 | 57 |
| 0 | 895 | 4 | 625 | 22 | 271 | 3 | 1952 | 4 | 895 | 4 | 625 | 22 | 271 | 3 | 1952 | 4 | 2 | 57 | 1 | 55 | 1 | 05 | 5 | 00 | 0 | 97 | 1 | 21 | 0 | 01 | 4 | 57 |
| 0 | 939 | 2 | 643 | 21 | 297 | 0 | 2006 | 8 | 939 | 2 | 643 | 21 | 297 | 0 | 2006 | 8 | 2 | 49 | 1 | 58 | 1 | 07 | 5 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| 0 | 1170 | 0 | 668 | 98 | 446 | 7 | 2313 | 2 | 1170 | 0 | 668 | 98 | 446 | 7 | 2313 | 2 | 2 | 96 | 1 | 65 | 1 | 12 | 5 | 00 | 0 | 00 | 0 | 00 | 0 | 00 | 0 | 00 |
| 0 | 1347 | 3 | 777 | 98 | 446 | 7 | 2373 | 8 | 1359 | 3 | 745 | 39 | 449 | 8 | 2413 | 2 | 2 | 90 | 1 | 66 | 1 | 08 | 5 | 00 | 1 | 27 | 1 | 31 | 0 | 02 | 4 | 40 |
| 0 | 1195 | 0 | [illegible] | 04 | 449 | 8 | 2413 | 2 | 1215 | 5 | 698 | 61 | 477 | 2 | 2473 | 7 | 2 | 48 | 1 | 50 | 1 | 08 | 5 | 00 | 1 | 27 | 1 | 72 | 0 | 02 | 4 | 57 |
| 0 | 1418 | 0 | 763 | 50 | 477 | 2 | 2473 | 7 | 1418 | 0 | 763 | 50 | 477 | 2 | 2473 | 7 | 2 | 93 | 1 | 67 | 1 | 08 | 5 | 00 | 1 | 32 | 1 | 34 | 0 | 02 | 4 | 40 |
| 0 | 1215 | 5 | 698 | 61 | 477 | 2 | 2473 | 7 | 1215 | 5 | 698 | 61 | 477 | 2 | 2473 | 7 | 2 | 47 | 1 | 50 | 1 | 08 | 5 | 00 | 1 | 36 | 1 | 87 | 0 | 02 | 4 | 57 |
| 0 | 1215 | 5 | 698 | 61 | 477 | 2 | 2473 | 7 | 1215 | 5 | 698 | 61 | 477 | 2 | 2473 | 7 | 2 | 47 | 1 | 50 | 1 | 08 | 5 | 00 | 0 | 96 | 1 | 20 | 0 | 02 | 4 | 40 |

Figure 4-39 RTP Leg 6 Light Pen Report (2 of 3)

MISSION SUMMARY REPORT

| OPERATOR NUMBER | TIME AVAILABLE | BUSY TIME MEAN | BUSY TIME STD | BUSY TIME MIN | BUSY TIME MAX | IDLE TIME MEAN | IDLE TIME STD | IDLE TIME MIN | IDLE TIME MAX | TOTAL TIME USED MEAN | TOTAL TIME USED STD | TOTAL TIME USED MIN | TOTAL TIME USED MAX | STRESS MEAN | STRESS STD | STRESS MIN | STRESS MAX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 16.5 | 581.8 | 688.3 | 2400.2 | [illegible] | [illegible] | 2713.0 | 2.04 | 0.11 | 1.80 | 2.40 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 17.0 | [illegible] | 724.0 | 2400.2 | [illegible] | [illegible] | 2713.0 | 1.91 | 0.12 | 1.67 | 2.31 |
| [illegible] | [illegible] | [illegible] | [illegible] | 1505.5 | 2609.5 | 688.2 | 17.0 | [illegible] | 724.0 | 2400.2 | [illegible] | 2273.7 | 2713.0 | 1.91 | 0.12 | 1.67 | 2.31 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 509.1 | 19.8 | 471.3 | 565.4 | 2400.2 | [illegible] | 2273.7 | 2713.0 | 2.03 | 0.11 | 1.77 | 2.42 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1707.0 | 717.4 | 55.1 | 603.5 | 991.7 | 2385.3 | 58.1 | [illegible] | 2661.3 | 2.38 | 0.05 | 2.32 | 2.55 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 2068.5 | 50.8 | 1939.7 | 2344.9 | 2385.3 | 58.1 | 2259.5 | 2661.3 | 1.77 | 0.05 | 1.71 | 1.95 |
| [illegible] | [illegible] | [illegible] | 3.0 | [illegible] | [illegible] | 2068.5 | 50.8 | 1939.7 | 2344.9 | 2385.3 | 58.1 | 2259.5 | 2661.3 | 1.77 | 0.05 | 1.71 | 1.95 |

97 SUCCESSFUL MISSIONS

3 UNSUCCESSFUL MISSIONS

Figure 4-39 RTP Leg 6 Light Pen Report (3 of 3)

TASK SUMMARY REPORT

*FOR 100 ITERATIONS*

| TASK NO | TASK TYPE | [illegible] | [illegible] | COUNTERS FAIL | COUNTERS SKIP | TIME TASK REALIZED MEAN | STD | MIN | MAX | TIME TASK COMPLETED MEAN | STD | MIN | MAX | TASK STRESS MEAN | STD | MIN | MAX | TASK COHESIVENESS MEAN | STD | MIN | MAX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MULT | 1.00 | 115 | 15 | 0 | 112.7 | 8.39 | 95.7 | 144.7 | 127.4 | 15.01 | 96.8 | 178.2 | 1.02 | 0.00 | 1.01 | 1.04 | 0.01 | 0.00 | 0.00 | 0.01 |
| 2 | MULT | 1.00 | 102 | 2 | 0 | 218.2 | 14.87 | 187.4 | 263.0 | 243.5 | 15.25 | 210.0 | 287.3 | 1.03 | 0.01 | 1.01 | 1.06 | 0.01 | 0.00 | 0.00 | 0.02 |
| 3 | MULT | 1.00 | 100 | 0 | 0 | 243.3 | 15.33 | 210.0 | 287.3 | 243.3 | 15.33 | 210.0 | 287.3 | 1.03 | 0.01 | 1.01 | 1.05 | 0.01 | 0.00 | 0.00 | [illegible] |
| 4 | MULT | 1.00 | 100 | 0 | 0 | 327.6 | 13.96 | 297.0 | 367.4 | 327.6 | 13.96 | 297.0 | 367.4 | 1.07 | 0.01 | 1.05 | 1.10 | 0.02 | 0.00 | 0.01 | 0.03 |
| 5 | MULT | 1.00 | 121 | [illegible] | 0 | 461.0 | 13.49 | 431.2 | 498.4 | 475.8 | 14.24 | 444.1 | 520.0 | 1.09 | 0.01 | 1.07 | 1.12 | 0.03 | 0.00 | 0.02 | 0.04 |
| 6 | MULT | 1.00 | [illegible] | [illegible] | 0 | 511.7 | 13.79 | 478.0 | 549.7 | 520.5 | 14.51 | 487.0 | 563.4 | 1.11 | 0.01 | 1.08 | 1.16 | 0.03 | 0.00 | 0.02 | 0.04 |
| 7 | MULT | 1.00 | [illegible] | [illegible] | 0 | 626.0 | 16.08 | 589.7 | 674.1 | 637.7 | 17.39 | 602.3 | 707.9 | 1.13 | 0.02 | 1.09 | 1.18 | 0.04 | 0.00 | 0.03 | 0.05 |
| 8 | MULT | 1.00 | 101 | 1 | 0 | 639.5 | 17.13 | 607.6 | 707.9 | 645.9 | 17.15 | 612.7 | 715.4 | 1.13 | 0.02 | 1.09 | 1.18 | 0.04 | 0.00 | 0.03 | 0.05 |
| 9 | MULT | 1.00 | [illegible] | [illegible] | 0 | [illegible] | 16.41 | 687.3 | 791.2 | 732.2 | 16.76 | 702.5 | 805.5 | 1.20 | 0.03 | 1.15 | 1.31 | 0.06 | 0.01 | 0.04 | 0.09 |
| 10 | MULT | 1.00 | [illegible] | 0 | 0 | [illegible] | 16.57 | 702.5 | 805.5 | 738.5 | 16.28 | 709.1 | 810.9 | 1.20 | 0.03 | 1.15 | 1.31 | 0.06 | 0.01 | 0.04 | 0.09 |
| 11 | MULT | 1.00 | [illegible] | 7 | 0 | 1231.1 | 26.60 | 1173.7 | 1342.5 | 1240.6 | 26.82 | 1183.0 | 1353.7 | 2.00 | 0.00 | 2.00 | 2.00 | 0.67 | 0.19 | 0.29 | 0.76 |
| 12 | MULT | 1.00 | 107 | 9 | 0 | 1264.9 | 27.86 | 1208.7 | 1378.5 | 1273.6 | 28.06 | 1215.4 | 1391.3 | 2.00 | 0.00 | 2.00 | 2.00 | 0.57 | 0.23 | 0.29 | 0.76 |
| 13 | MULT | 1.00 | 101 | 1 | 0 | 1732.3 | 29.02 | 1674.4 | 1850.4 | 1746.8 | 28.80 | 1688.8 | 1862.9 | 2.00 | 0.00 | 2.00 | 2.00 | 0.29 | 0.00 | 0.29 | 0.29 |
| 14 | MULT | 1.00 | 102 | [illegible] | 0 | [illegible] | 45.37 | 2235.3 | 2450.2 | 2332.3 | 47.93 | 2246.4 | 2507.7 | 2.05 | 0.21 | 2.00 | 3.20 | 0.47 | 0.20 | 0.31 | 1.66 |
| 15 | MULT | 1.00 | [illegible] | 0 | 0 | [illegible] | 57.94 | 2290.9 | 2640.4 | 2397.7 | 63.29 | 2304.4 | 2692.2 | 2.12 | 0.59 | 2.00 | 5.00 | 0.49 | 0.84 | 0.29 | 4.57 |
| [illegible] | MULT | 1.00 | [illegible] | 0 | 0 | [illegible] | 48.36 | 2246.4 | 2507.7 | 2332.2 | 48.36 | 2246.4 | 2507.7 | 2.55 | 0.33 | 2.50 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 21 | SING | 1.00 | 100 | 0 | 0 | 2332.2 | 48.36 | 2246.4 | 2507.7 | 2332.2 | 48.36 | 2246.4 | 2507.7 | 2.06 | 0.37 | 2.00 | 5.00 | 0.35 | 0.49 | 0.29 | 4.57 |
| [illegible] | SING | 1.00 | 100 | 0 | 0 | 2332.2 | 48.36 | 2245.4 | 2507.7 | 2350.3 | 51.39 | 2263.8 | 2565.3 | 2.06 | 0.37 | 2.00 | 5.00 | 0.35 | 0.49 | 0.29 | 4.57 |
| [illegible] | MULT | 1.00 | 103 | [illegible] | 0 | 2332.2 | 48.36 | 2246.4 | 2507.7 | 2368.0 | 57.58 | 2279.8 | 2627.6 | 2.08 | 0.44 | 2.00 | 5.00 | 0.37 | 0.56 | 0.29 | 4.57 |
| [illegible] | SING | 1.00 | 100 | 0 | 0 | 2332.2 | 48.36 | 2246.4 | 2507.7 | 2368.1 | 57.64 | 2279.8 | 2629.6 | 2.08 | 0.44 | 2.00 | 5.00 | 0.37 | 0.56 | 0.29 | 4.57 |
| [illegible] | MULT | 1.00 | [illegible] | 0 | 0 | 2368.1 | 57.67 | 2279.8 | 2629.6 | 2368.1 | 57.67 | 2279.8 | 2627.6 | 2.60 | 0.49 | 2.50 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | MULT | 1.00 | 100 | 0 | 0 | 888.2 | 27.11 | 839.3 | 1008.4 | 888.2 | 27.11 | 839.3 | 1008.4 | 1.67 | 0.14 | 1.46 | 2.49 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | SING | 1.00 | 100 | 0 | 0 | 888.2 | 27.11 | 839.3 | 1008.4 | 906.6 | 26.23 | 859.7 | 1026.5 | 1.45 | 0.09 | 1.31 | 1.99 | 0.13 | 0.03 | 0.09 | 0.28 |
| [illegible] | SING | 1.00 | 100 | 0 | 0 | 888.2 | 27.11 | 839.3 | 1008.4 | 920.7 | 26.80 | 874.0 | 1042.5 | 1.67 | 0.14 | 1.46 | 2.49 | 0.13 | 0.03 | 0.09 | 0.26 |
| [illegible] | SING | 1.00 | 100 | 0 | 0 | 906.6 | 26.23 | 859.7 | 1026.5 | 906.6 | 26.23 | 859.7 | 1026.5 | 1.45 | 0.09 | 1.31 | 1.99 | 0.13 | 0.03 | 0.09 | 0.28 |
| 30 | SING | 1.00 | 100 | 0 | 0 | 906.6 | 26.23 | 859.7 | 1026.5 | 924.8 | 25.38 | 880.5 | 1043.5 | 1.45 | 0.09 | 1.31 | 1.99 | 0.13 | 0.03 | 0.09 | 0.28 |
| 31 | MULT | 1.00 | 100 | 0 | 0 | 888.2 | 27.11 | 839.3 | 1008.4 | 923.6 | 25.41 | 878.6 | 1041.5 | 1.45 | 0.09 | 1.31 | 1.99 | 0.13 | 0.03 | 0.09 | 0.28 |
| 32 | SING | 1.00 | 100 | 0 | 0 | 888.2 | 27.11 | 839.3 | 1008.4 | 923.6 | 25.42 | 878.6 | 1041.5 | 1.45 | 0.09 | 1.31 | 1.99 | 0.13 | 0.03 | 0.09 | 0.28 |
| 33 | MULT | 1.00 | 100 | 0 | 0 | 924.8 | 25.40 | 880.5 | 1043.5 | 924.8 | 25.40 | 880.5 | 1043.5 | 1.68 | 0.15 | 1.46 | 2.62 | 0.00 | 0.00 | 0.00 | 0.00 |
| 34 | MULT | 1.00 | 300 | 0 | 0 | 1142.6 | 619.91 | 376.1 | 2041.9 | 1142.6 | 619.91 | 376.1 | 2041.9 | 2.90 | 1.60 | 1.10 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 35 | SING | 1.00 | 300 | 0 | 0 | 1142.6 | 619.91 | 376.1 | 2041.9 | 1237.0 | 648.56 | 428.1 | 2164.5 | 3.21 | 1.59 | 1.10 | 5.00 | 1.77 | 1.82 | 0.02 | 4.57 |
| 36 | SING | 1.00 | 300 | 0 | 0 | 1142.6 | 619.91 | 376.1 | 2041.9 | 1171.2 | 634.11 | 403.7 | 2104.0 | 3.16 | 1.60 | 1.07 | 5.00 | 1.74 | 1.80 | 0.02 | 4.57 |
| 37 | SING | 1.00 | 300 | 0 | 0 | 1171.2 | 634.11 | 403.7 | 2104.0 | 1192.0 | 632.63 | 403.7 | 2104.0 | 3.29 | 1.61 | 1.07 | 5.00 | 1.73 | 1.74 | 0.02 | 4.57 |
| 38 | MULT | 1.00 | 300 | 0 | 0 | 1142.6 | 619.91 | 376.1 | 2041.9 | 1236.2 | 642.37 | 430.7 | 2161.1 | 3.11 | 1.58 | 1.07 | 5.00 | 1.66 | 1.73 | 0.02 | 4.57 |
| 39 | SING | 1.00 | 300 | 0 | 0 | 1192.0 | 632.63 | 403.7 | 2104.0 | 1242.0 | 646.54 | 431.2 | 2153.8 | 3.23 | 1.62 | 1.07 | 5.00 | 1.89 | 1.94 | 0.02 | 4.57 |
| 40 | SING | 1.00 | 300 | 0 | 0 | 1142.6 | 619.91 | 376.1 | 2041.9 | 1239.4 | 646.39 | 429.1 | 2160.5 | 3.30 | 1.61 | 1.07 | 5.00 | 1.76 | 1.82 | 0.02 | 4.57 |
| [illegible] | MULT | [illegible] | [illegible] | 0 | 0 | 1243.2 | 647.67 | 431.2 | 2164.5 | 1243.2 | 647.67 | 431.2 | 2164.5 | 2.91 | 1.51 | 1.10 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | [illegible] | [illegible] | [illegible] | 0 | 0 | 1109.9 | 465.67 | 612.7 | 1693.0 | 1109.9 | 465.67 | 612.7 | 1693.0 | 1.87 | 0.63 | 1.18 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | [illegible] | [illegible] | [illegible] | 0 | 0 | 1109.9 | 465.67 | 612.7 | 1693.0 | 1131.1 | 463.43 | 637.2 | 1710.5 | 1.60 | 0.52 | 1.12 | 2.37 | 0.21 | 0.17 | 0.03 | 0.46 |
| [illegible] | SING | [illegible] | [illegible] | 0 | 0 | 1109.9 | 465.67 | 612.7 | 1693.0 | 1191.3 | 504.42 | 658.9 | 1812.8 | 2.37 | 1.13 | 1.18 | 3.50 | 0.52 | 0.48 | 0.03 | 1.00 |
| [illegible] | MULT | [illegible] | [illegible] | 0 | 0 | 1109.9 | 465.67 | 612.7 | 1693.0 | 1150.7 | 459.17 | 662.7 | 1727.9 | 1.65 | 0.49 | 1.12 | 2.31 | 0.20 | 0.15 | 0.03 | 0.43 |
| [illegible] | [illegible] | [illegible] | [illegible] | 0 | 0 | 1131.1 | 462.43 | 637.2 | 1710.5 | 1172.0 | 456.07 | 687.3 | 1745.4 | 1.68 | 0.51 | 1.12 | 2.36 | 0.21 | 0.17 | 0.03 | 0.46 |
| [illegible] | SING | [illegible] | [illegible] | 0 | 0 | 1109.9 | 465.67 | 612.7 | 1693.0 | 1151.0 | 459.43 | 663.0 | 1727.4 | 1.70 | 0.54 | 1.12 | 2.43 | 0.22 | 0.18 | 0.03 | 0.49 |
| [illegible] | MULT | [illegible] | [illegible] | 0 | 0 | 1205.8 | 489.89 | 687.3 | 1812.8 | 1205.8 | 489.89 | 687.3 | 1812.8 | 1.90 | 0.60 | 1.23 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | MULT | [illegible] | [illegible] | 0 | 0 | 921.7 | 353.75 | 537.2 | 1391.3 | 921.7 | 353.75 | 537.2 | 1391.3 | 2.07 | 1.11 | 1.14 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | SING | [illegible] | [illegible] | 0 | 0 | 921.7 | 353.75 | 537.2 | 1391.3 | 930.3 | 362.42 | 537.2 | 1409.8 | 1.57 | 0.44 | 1.09 | 2.08 | 0.20 | 0.21 | 0.03 | 0.76 |
| [illegible] | SING | [illegible] | [illegible] | 0 | 0 | 921.7 | 353.75 | 537.2 | 1391.3 | 1004.4 | 391.05 | 586.0 | 1512.9 | 2.48 | 1.36 | 1.14 | 5.00 | 0.82 | 1.27 | 0.03 | 4.57 |
| [illegible] | SING | [illegible] | [illegible] | 0 | 0 | 950.3 | 352.42 | 537.2 | 1409.8 | 951.7 | 358.25 | 563.0 | 1428.3 | 1.57 | 0.44 | 1.09 | 2.10 | 0.21 | 0.21 | 0.03 | 0.76 |
| [illegible] | MULT | 1.00 | [illegible] | 0 | 0 | 921.7 | 353.75 | 537.2 | 1391.3 | 963.1 | 345.56 | 589.5 | 1424.9 | 1.56 | 0.44 | 1.09 | 2.04 | 0.20 | 0.21 | 0.03 | 0.76 |
| [illegible] | SING | [illegible] | [illegible] | 0 | 0 | 951.7 | 358.25 | 563.0 | 1428.3 | 973.0 | 354.00 | 589.7 | 1446.0 | 1.57 | 0.44 | 1.09 | 2.09 | 0.20 | 0.21 | 0.03 | 0.76 |
| [illegible] | SING | [illegible] | [illegible] | 0 | 0 | 921.7 | 353.75 | 537.2 | 1391.3 | 963.1 | 345.65 | 589.1 | 1425.5 | 1.57 | 0.45 | 1.09 | 2.12 | 0.21 | 0.21 | 0.03 | 0.76 |
| [illegible] | MULT | [illegible] | [illegible] | 0 | 0 | 1007.3 | 388.19 | 589.7 | 1512.9 | 1007.3 | 380.[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | MULT | [illegible] | [illegible] | 0 | 0 | 967.7 | 676.68 | 96.8 | 2164.5 | 967.7 | 676.[illegible] | [illegible] | 2164.5 | [illegible] | [illegible] | [illegible] | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| [illegible] | SING | [illegible] | [illegible] | 0 | 0 | 967.7 | 676.68 | 96.8 | 2164.5 | 1002.1 | 687.[illegible] | [illegible] | 2228.0 | [illegible] | [illegible] | [illegible] | 5.00 | 0.76 | 0.87 | 0.00 | [illegible] |



Figure 4-40 RTP Leg 6 Push Button Report (1 of 3)

| | | | | | | |
|---|---|---|---|---|---|---|
| [illegible] | 1065 1 685 [illegible] | 127 4 2228 0 | 1065 4 685 [illegible] | 127 4 2228 0 | 2 60 1 33 1 01 5 00 | 0 83 1 00 0 00 4 57 |
| [illegible] | 1005 4 615 [illegible] | 127 4 2228 0 | 1017 7 705 49 | 127 4 2293 5 | 2 61 1 32 1 01 5 00 | 0 84 1 00 0 00 4 57 |
| [illegible] | 967 2 [illegible] | 96 8 2164 5 | 1092 8 721 57 | 183 7 2343 1 | 2 59 1 01 1 02 4 49 | 0 71 0 60 0 00 3 13 |
| [illegible] | 1017 5 707 [illegible] | 137 4 2293 5 | 1032 7 695 56 | 157 3 2293 5 | 2 63 1 35 1 01 5 00 | 0 93 1 17 0 06 4 57 |
| [illegible] | [illegible] | 157 3 2293 5 | 1038 7 688 40 | 187 4 2293 5 | 2 64 1 37 1 01 5 00 | 0 93 1 16 0 00 4 57 |
| [illegible] | 967 7 676 [illegible] | 96 8 2164 5 | 1063 1 707 20 | 185 5 2343 9 | 2 45 1 17 1 01 5 00 | 0 72 0 63 0 00 4 30 |
| [illegible] | 967 7 676 [illegible] | 96 8 2164 5 | 1072 4 710 63 | 184 3 2346 9 | 2 56 1 25 1 01 5 00 | 0 77 0 86 0 00 4 48 |
| [illegible] | 1094 3 720 83 | 187 4 2346 9 | 1094 3 720 83 | 187 4 2346 9 | 2 63 1 37 1 02 5 00 | 0 66 0 00 0 00 0 00 |
| [illegible] | 0 0 0 00 | 0 0 0 0 | 0 0 0 00 | 0 0 0 0 | 1 00 0 00 1 00 1 00 | 0 00 0 00 0 00 0 00 |
| [illegible] | 0 0 0 00 | 0 0 0 0 | 0 0 0 00 | 0 0 0 0 | 1 00 0 00 1 00 1 00 | 0 00 0 00 0 00 0 00 |
| [illegible] | 0 0 0 00 | 0 0 0 0 | 30 9 1 00 | 28 1 32 6 | 1 00 0 00 1 00 1 00 | 0 00 0 00 0 00 0 00 |
| [illegible] | 41 5 3 14 | 30 1 52 3 | 43 1 6 55 | 30 7 74 7 | 1 00 0 00 1 00 1 00 | 0 00 0 00 0 00 0 00 |
| [illegible] | 43 1 6 43 | 30 7 74 7 | 53 5 7 45 | 35 7 90 3 | 1 00 0 00 1 00 1 00 | 0 00 0 00 0 00 0 00 |
| [illegible] | 53 5 7 45 | 35 7 90 3 | 110 9 6 86 | 94 9 144 7 | 1 03 0 01 1 01 1 06 | 0 01 0 00 0 00 0 01 |
| [illegible] | 53 5 7 45 | 35 7 90 3 | 63 5 8 50 | 42 4 102 2 | 1 02 0 00 1 01 1 04 | 0 01 0 00 0 00 0 01 |
| [illegible] | 64 7 9 40 | 42 4 102 2 | 75 3 11 36 | 51 5 106 3 | 1 02 0 00 1 01 1 04 | 0 01 0 00 0 00 0 01 |
| [illegible] | 75 5 11 38 | 51 5 106 3 | 84 6 11 92 | 61 0 118 8 | 1 02 0 00 1 01 1.04 | 0 01 0 00 0 00 0 01 |
| [illegible] | 84 6 11 92 | 61 0 118 8 | 96 8 12 21 | 69 5 129 4 | 1 02 0 00 1 01 1 04 | 0 01 0 00 0 00 0 01 |
| [illegible] | 111 6 7 25 | 95 7 144 7 | 111 6 7 25 | 95 7 144 7 | 1 03 0 01 1 01 1 06 | 0 00 0 00 0 00 0 00 |
| [illegible] | 2031 1 340 96 | 1636 3 2629 6 | 2031 1 340 96 | 1636 3 2629 6 | 3 01 0 83 2 50 5 00 | 0.00 0.00 0 00 0 00 |
| [illegible] | 2031 1 340 96 | 1636 3 2629 6 | 2047 7 324 45 | 1669 5 2629 6 | 3 13 1 21 2 00 5 00 | 0 96 0 90 0 29 4 57 |
| [illegible] | 2047 7 324 45 | 1669 5 2629 6 | 2057 0 329 42 | 1674 4 2640 4 | 2 98 1 11 2 00 5 00 | 0 87 0 86 0 29 4 57 |
| [illegible] | 2057 0 329 42 | 1674.4 2640 4 | 2057 0 329 42 | 1674.4 2640 4 | 3.07 1 18 2 00 5 00 | 0 93 0 89 0 29 4 57 |
| [illegible] | 2057 0 329 42 | 1674 4 2640 4 | 2057 0 329 42 | 1674 4 2640 4 | 3 07 1 18 2 00 5 00 | 0 93 0 89 0.29 4 57 |
| [illegible] | 2057 0 329 42 | 1674 4 2640 4 | 2057 0 329 42 | 1674 4 2640 4 | 2 97 0 82 2 50 5 00 | 0 00 0 00 0 00 0 00 |
| [illegible] | 810 5 601 89 | 210 0 1862 9 | 810 5 601 89 | 210 0 1862 9 | 2 02 0 96 1 04 5 00 | 0.00 0 00 0.00 0 00 |
| [illegible] | 810 5 601 89 | 210 0 1862 9 | 852 0 612 37 | 239 8 1920 3 | 2 21 1 15 1 03 5 00 | 0 58 0 63 0 01 3 65 |
| [illegible] | 852 0 612 37 | 239 8 1920 3 | 894 9 624 46 | 271 3 1987 4 | 2 36 1.32 1 03 5 00 | 0 67 0.76 0 01 4.57 |
| [illegible] | 852 0 612 37 | 239 8 1920 3 | 936 0 644 33 | 293 7 2036 2 | 2 68 1 61 1 07 5 00 | 0 82 0.94 0 01 4.57 |
| [illegible] | 852 0 612 37 | 239 8 1920 3 | 916 9 637 57 | 297 0 2041 9 | 1 92 0 99 1 03 3 50 | 0 38 0 41 0 01 1 33 |
| [illegible] | 894 9 624 40 | 271 3 1987 4 | 894 9 624 40 | 271 3 1987 4 | 2 57 1 56 1 05 5 00 | 0 97 1 21 0 01 4 57 |
| [illegible] | 894 9 624 40 | 271 3 1987 4 | 894 9 624 40 | 271 3 1987 4 | 2 57 1 56 1 05 5 00 | 0 97 1 21 0.01 4 57 |
| [illegible] | 938 8 642 56 | 297 0 2041 9 | 938 8 642 56 | 297 0 2041 9 | 2 49 1 57 1 07 5 00 | 0 00 0 00 0 00 0 00 |
| [illegible] | 1167 6 668 46 | 446 7 2346 9 | 1167 6 668 46 | 446.7 2346.9 | 2 95 1 64 1 12 5.00 | 0 00 0 00 0 00 0 00 |
| [illegible] | 1372 7 759 98 | 446 7 2368 4 | 1383 6 746 79 | 450 7 2392 9 | 2 95 1 67 1 08 5 00 | 1 31 1 32 0 02 4 57 |
| [illegible] | 1163 1 681 04 | 450 7 2392 9 | 1213 7 697 51 | 478 0 2450.2 | 2 48 1.50 1 08 5 00 | 1.27 1 71 0 02 4 57 |
| [illegible] | 1409 0 761 82 | 478 0 2450 2 | 1409 0 761 82 | 478 0 2450 2 | 2 92 1 67 1 08 5 00 | 1 30 1 32 0 02 4 57 |
| [illegible] | 1213 7 697 51 | 478 0 2450 2 | 1213 7 697 51 | 478 0 2450 2 | 2 47 1 50 1 08 5 00 | 1 36 1 87 0 02 4 57 |
| [illegible] | 1213 7 697 51 | 478 0 2450 2 | 1213 7 697 51 | 478.0 2450.2 | 2 47 1 50 1 08 5.00 | 0 96 1 19 0 02 4 57 |

Figure 4-40 RTP Leg 6 Push Button Report (2 of 3)

MISSION SUMMARY REPORT

| CRITERIA NUMBER | FUEL AVAILABLE | BUSY TIME MEAN | STD | MIN | MAX | IDLE TIME MEAN | STD | MIN | MAX | TOTAL TIME USED MEAN | STD | MIN | MAX | STRESS MEAN | STD | MIN | MAX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | [illegible] | [illegible] | 63.7 | [illegible] | [illegible] | [illegible] | 17.5 | 501.8 | [illegible] | 2397.7 | [illegible] | 2304.4 | 2692.2 | 2.03 | 0.11 | [illegible] | 2.43 |
| 2 | [illegible] | [illegible] | 57.[illegible] | [illegible] | 1777.3 | 670.4 | 15.1 | 510.0 | [illegible] | 2397.7 | [illegible] | 2304.4 | 2692.2 | 1.71 | 0.13 | 1.68 | 2.33 |
| 3 | [illegible] | 1707.3 | 67.8 | [illegible] | 1997.4 | 650.4 | 15.1 | 640.0 | 728.6 | 2397.7 | 63.3 | 2304.4 | 2692.2 | 1.91 | 0.13 | 1.68 | 2.33 |
| 4 | [illegible] | 1637.1 | [illegible] | [illegible] | 2183.4 | 510.7 | 20.3 | [illegible] | 581.1 | 2397.7 | 63.3 | 2304.4 | 2692.2 | 2.05 | 0.1[illegible] | 1.85 | 2.41 |
| 5 | [illegible] | [illegible] | [illegible] | [illegible] | 1704.1 | 714.1 | 55.3 | [illegible] | 784.9 | 2302.4 | 57.9 | 2220.9 | 2640.4 | 2.38 | 0.05 | [illegible] | 2.56 |
| 6 | [illegible] | 317.1 | [illegible] | [illegible] | 350.0 | 2064.2 | 57.[illegible] | 1970.6 | 2321.7 | 2302.4 | 57.9 | 2290.[illegible] | 2640.4 | 1.77 | 0.05 | 1.71 | 1.71 |
| 7 | [illegible] | 317.7 | 4.5 | [illegible] | 350.0 | 2065.3 | 57.6 | 1970.6 | 2321.7 | 2302.4 | 57.9 | 2290.[illegible] | 2640.4 | 1.77 | 0.05 | 1.71 | 1.91 |

96 SUCCESSFUL MISSIONS

4 UNSUCCESSFUL MISSIONS

Figure 4-40  RTP Leg 6 Push Button Report (3 of 3)

### 4.1.3.3.2 Dynamic Test/Activate Discrete Malfunction (Cont'd)

The operator stresses were:

Operator 1 - 2.03
Operator 2 - 1.91
Operator 3 - 1.91
Operator 4 - 2.03
Operator 5 - 2.38
Operator 6 - 1.77
Operator 7 - 1.77

A summary of these results appears in Table 4-12.

Table 4-12 Value Summary

| | | KEYBOARD | PUSH BUTTON | LIGHT PEN |
|---|---|---|---|---|
| Mean time of completion (seconds) | | 2432.6 | 2400.2 | 2397.7 |
| Mean stress/operator | 1 | 2.09 | 2.04 | 2.03 |
| | 2 | 1.98 | 1.91 | 1.91 |
| | 3 | 1.98 | 1.91 | 1.91 |
| | 4 | 2.09 | 2.03 | 2.03 |
| | 5 | 2.40 | 2.38 | 2.38 |
| | 6 | 1.77 | 1.77 | 1.77 |
| | 7 | 1.77 | 1.77 | 1.77 |
| Successful missions/100 | | 88 | 97 | 96 |
| Time allowed for mission (seconds) | | 2500 | 2500 | 2500 |

The keyboard, although not unsuitable for this task, was not as suitable as the push button and light pen. Its time of completion was 67.4 seconds under the allowed mission time, and the operator stress values were all under the stress thresholds of 2.50. The stress values, however, were 2.68% greater than those of the push button and light pen operators.

The light pen and the push button interfaces were both suitable to the malfunction task. The time they take to perform the mission differs by 3.6 seconds and the stress value for the operators is almost the same.

In conclusion, in performing mapping tasks the push button interface was most effective, followed by the keyboard. The light pen was unsuitable. In performing the discrete malfunction task, all three interfacing methods were suitable, but the keyboard was least effective while the light pen and push button interfaces were equally suitable. From these results, the choice of candidate methods should be, in decreasing effectiveness:

(1) Push button

(2) Keyboard

(3) Light pen.

4.1.4 Summary. Two evaluations were performed. The first evaluation compared two different IOS configurations. The second evaluation was performed in order to compare the suitability of three candidate interface techniques to two commonly performed instructor tasks.

The evaluation of the two IOS configurations was twofold: static and dynamic. The static phase of the evaluation consisted of choosing TAMs which described the IOS activities pertinent to the jet trainer console. The tasks comprising these chosen TAMs were assigned parameters from Appendix G (PARAMINDX). The appropriate tasks were then designated dormant, time allotments were assigned to the TAMs and they were then run by SAINT. The results of these TAMs were then used as parameter sets for the dynamic phase of the evaluation.

The dynamic phase consisted of running the validated RTP using the data obtained from the static phase. Each leg of the RTP was run twice, once with the TAM data from configuration #1, and once with data from configuration #2. The data generated from these RTP runs were analyzed with respect to number of successful missions, stress values on the operators and time of completion. A summary of these results is given in Table 4-13.

Table 4-13 Comparative Summary

| | | #1 | #2 |
|---|---|---|---|
| Time for completion (seconds) | RTP3 | 1846.7 | 1834.1 |
| | RTP4 | 1415.7 | 1373.9 |
| | RTP5 | 1470.9 | 1457.8 |
| | RTP6 | 2496.0 | 2457.3 |
| | RTP7 | 524.0 | 534.6 |
| Average operator stress (on operator registering higest) | RTP3 | 2.25 (OP#4) | 2.23 (OP#4) |
| | RTP4 | 1.47 (OP#5) | 1.40 (OP#5) |
| | RTP5 | 1.54 (OP#1) | 1.48 (OP#1) |
| | RTP6 | 2.19 (OP#1&4) | 2.08 (OP#1&4) |
| | RTP7 | 1.06 (OP#1) | 1.05 (OP#1) |
| Number of successful missions/100 | RTP3 | 65 | 78 |
| | RTP4 | 86 | 92 |
| | RTP5 | 70 | 80 |
| | RTP6 | 80 | 83 |
| | RTP7 | 100 | 100 |

The #2 configuration surpasses that of #1 in number of successful missions, lighter stress and less time used.

The evaluation of the candidate interface techniques was done in dynamic and static phases. The static phase consisted of using the three techniques (keyboard, push button and light pen) to perform two instructor tasks (averaging map displays and activating discrete malfunctions). The results showed that, for the map arrangement, the push button TAM was the most effective, then the keyboard. The light pen proved to be unsuitable. For the activation of discrete malfunctions, all three techniques were suitable. However, the keyboard was the least suitable interface, while the push button was most effective, followed closely by the light pen technique.

The parameters obtained from running these TAMs were then implemented into leg 6 of the RTP for dynamic testing. Each of the three interface methods were inserted whenever a mapping display was needed. The order of effectiveness of the interface methods, based on number of successful missions, average stress on operators and time necessary for completion were (1) push button, (2) keyboard, (3) light pen.

The parameters obtained from the malfunction TAM were then implemented in the RTP. The order of effectiveness of the interface methods, based on the same criteria as above, were (1) push button and light pen, (2) keyboard.

In conclusion, if hardware were to be implemented on an IOS in order to perform the above two tasks, the light pen, although most effective for activating discrete malfunctions, is unsuitable for map arranging and is thus the least desirable. The push button interface is most suitable for both tasks, followed by the keyboard.

4.2 Presentation of New Design Concepts. An on-board instructor/operator station (shown in Figure 4-41) was analyzed and then was redesigned utilizing the concepts learned from the evaluation of interfacing techniques and off-hand IOS designs (paragraph 4.1).

This IOS design consists of two CRTs separated by a panel of push buttons. A separate panel, containing the controls for the instructor interphone, is situated above one of the CRTs. The push button panel is divided into five subsections. The first section contains a real time clock and three potentiometers controlling the intensity of the panel lights, ceiling lights, and push button lights. The next panel contains a series of push buttons associated with slewing aircraft fuel tank quantities, and various miscellaneous functions. The third panel is the station/position panel. This panel provides the capabilities to control the status of ground radio stations. The simulator control panel contains controls for the motion system and emergency conditions. The last panel, the instructor audio panel, consists of toggle switches, push buttons, indicator lights and a volume control which allows the instructor to communicate with the flight crew via private or regular aircraft communications.

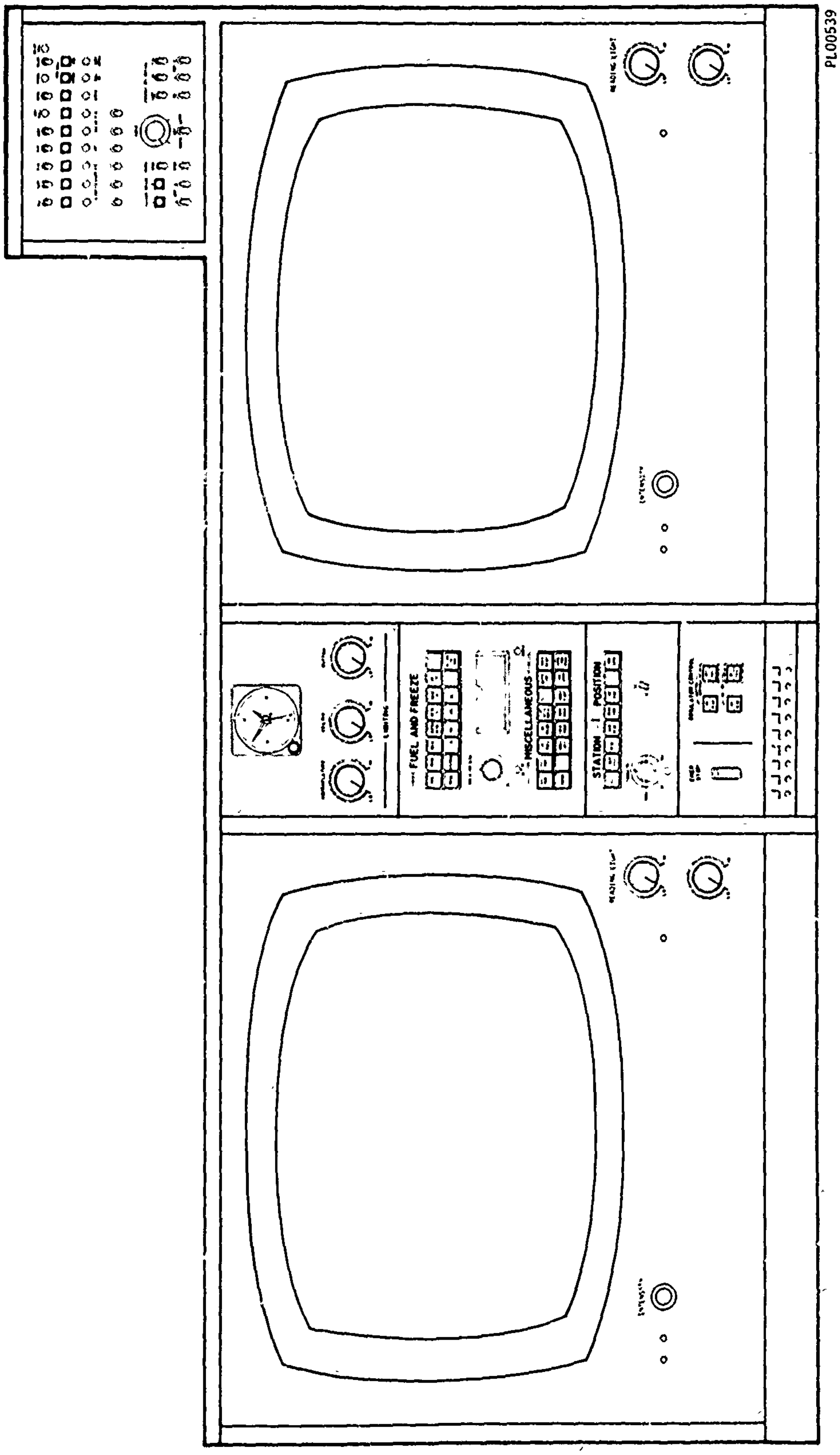



Figure 4-41 On-Board IOS

4.2 Presentation of New Design Concepts (Cont'd)

In this IOS, as in most other commercial aircraft simulators, there are no repeater instruments because the instructor is in close enough proximity to the trainee to see the actual instruments.

This design is simple, straightforward and functional. The keyboard allows easy access to the computer information which is displayed on the CRTs, while the push buttons facilitate the implementation of commonly used parameters.

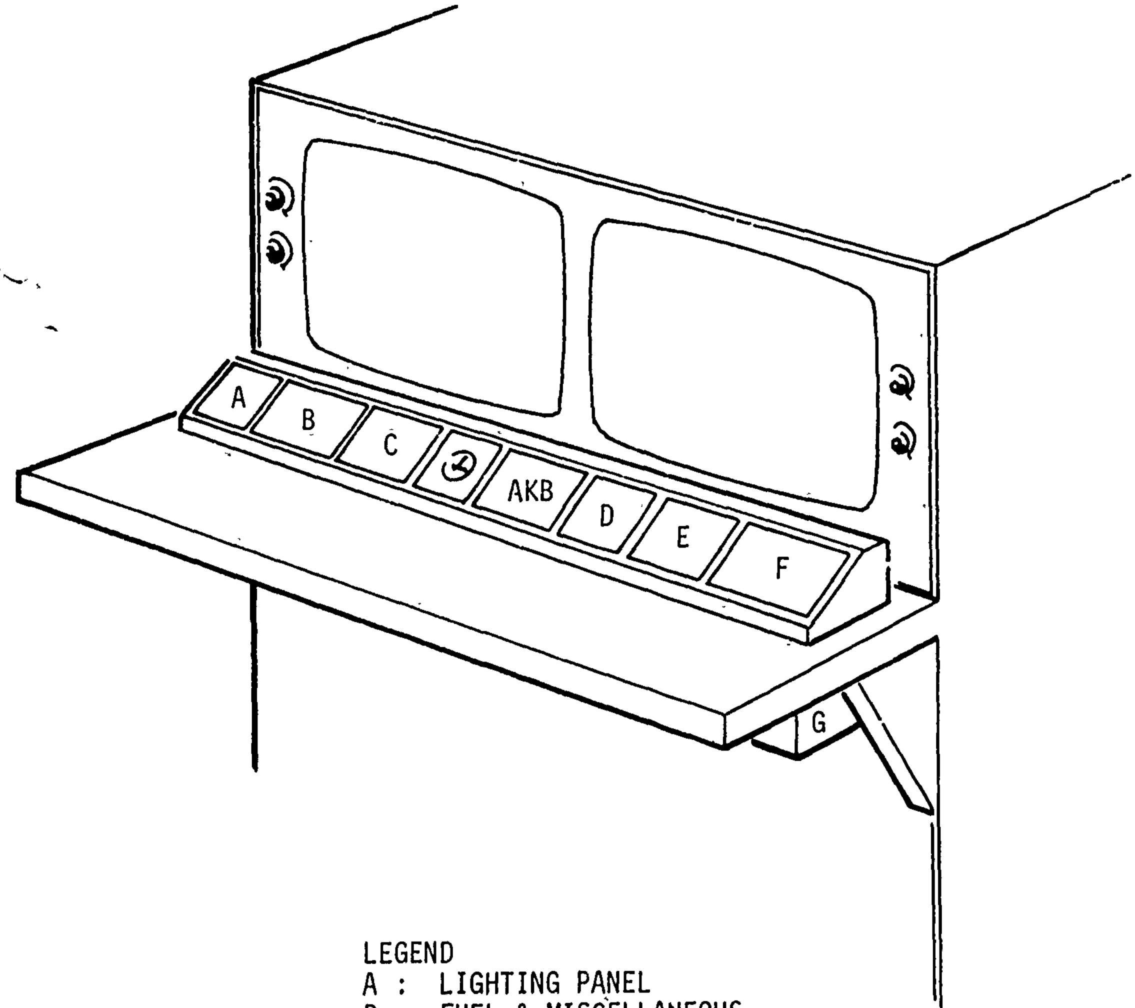
However, as a result of the analyses performed (paragraph 4-1) on the jet trainer IOS, the information exists to improve this IOS.

The jet trainer analysis showed that an IOS which requires little eye and head motion, and small travel distances to physically access devices, improves the usability of an IOS. The trainer analysis of the three candidate interface methods revealed the light pen to be the least desirable while a conservative arrangment of push buttons is the best with the keyboard as an all-purpose desirable device).

The interface devices already implemented on this IOS are the keyboard, dedicated push buttons, and potentiometers. The push buttons are arranged in separate groups of 2 x 8 matrices. Although these are banks of push buttons, they are not so large that the instructor must search for a particular button. The labelling of the buttons is clear and easily read.

These devices, however, can be employed further to enhance the usability of the IOS. The IOS designed with the newly obtained information is shown in Figure 4-42. The panel has been removed from between the CRTs, thus eliminating the tennis match effect of looking from the left CRT and across a panel to the right CRT (which was an undesirable feature of the jet trainer #1). The instructor can now visually access both displays with negligible eye and head movement.

The new design also eliminates much of the distance travelled in manual access tasks. The panel and keyboard are situated on a wedge in front of the CRTs (this is a very popular concept, used frequently in power generating station simulators). This arrangement (with the use of no-glare push buttons) is visually more appealing, and manually easier to access due to the proximity of the interface devices to the instructor. The desirability of this proximity was shown in the evaluation of #2 where, although visual access tasks were greatly facilitated, manual tasks become more difficult when the panel was placed on the far right of the console. The removal of the panel from between the CRTs also eliminates the possibility of the instructor inadvertently covering up a vital display while trying to access a device. It must be strictly noted that if any interface device accesses only one specific CRT, that device will be situated on the panel wedge directly in front of the CRT it accesses. For example, if approach plots and maps are most commonly called up on the right CRT, the third panel (station/position) should be in front of the right CRT.




LEGEND
A : LIGHTING PANEL
B : FUEL & MISCELLANEOUS
C : DIRECT LINE SELECT
D : SIMULATOR CONTROL
E : STATION POSITION
F : INSTRUCTOR INTERPHONE
G : VOICE RECORDER

Figure 4-42 On-Board IOS (Improved)

4.2 <u>Presentation of New Design Concepts (Cont'd)</u>

More extensive use of the interface devices chosen will also improve the IOS from the point of view of the instructor pilot. While the keyboard is a very suitable method of activating lines on a CRT page, direct line select buttons have proven (as in paragraph 4.1) to be more expedient. The relative simplicity of this design and the lack of large amounts of hardware allow this. Thus, the lines can be activated both by the keyboard and the push buttons. Since there are 40 lines per CRT page, this bank of push buttons can be arranged as a 4 x 10 matrix.

A voice recorder, activated by a foot pedal or kneebar, is implemented in the new design to allow instructors to record notes (for their own use) while assessing trainee performance. This will not take the place of the formal notes which must be made, but may replace the quick jottings instructors make during an assessment. Each assessment module of the RTP contains an ongoing MAKE WRITTEN NOTES task which adds to the stress level of the emulated manual operator. The voice recorder will free the manual operator, thus lowering the stress which will, in turn, add an organizing influence to the other emulated operators. This feature is also justified by the fact that, throughout the RTP, the least used emulated operators (also the operators with the lowest stress levels) are the verbal and pedal operators.

These design concepts will have the effect of lowering the stress imposed on the instructor pilot by making the tools of training more readily accessable, more easily usable, and more evenly spread over the instructor's basic human capabilities.

## 5. CONCLUSIONS

5.1 Model Effectiveness. The main thrust of this work was to develop an analytical tool to assist in IOS design and assessment. The tool was applied to two alternate IOS configurations and produced reasonable results. Clearly, the IOS model can be used with confidence, provided that sufficient data are available to describe accurately the component devices of the IOS.

In its present state, the model proves to be a useful tool in assessing alternate configurations or devices. With a larger data base, particularly in terms of a larger number of operators, it should be possible to use the model to establish design principles and constraints. For example, the model could be used to identify generically those functions suitable for dedicated push buttons and those suitable for keyboard/CRT. Based on model results, definitive statements on the use of color or layout of displays, etc., could be made.

The limiting factor in defining the effectiveness of the model is experience. The development of the model is evolutionary since assumptions are made which can be validated only by applying the model and reviewing the results. The fact that reasonable results were achieved in the two test runs serves to verify the assumptions made in developing the model.

5.2 User Benefits. This section is to identify some of the benefits which a user may achieve through the use of the evaluation tool described in this report. It is anticipated that users will include designers of instructor support systems similar to the IOS, evaluators or analysts of existing equipment attempting to determine effectiveness or identify functional problems, and those upgrading or retrofitting existing equipment.

Depending on the user's purpose, it may be necessary to examine or to predict the performance of a given interface in a sequence of operative tasks, to identify potential sources of time delay and generators of error, or to determine the requirements for additional equipment or functional capabilities to relieve the workload.

The user may wish to analyze an existing design and determine its suitability and effectiveness in a new application, or to determine its capacity to accept additional tasks. It may be that the assignment of tasks between the instructor and the supporting subsystems and functions is in question, i.e., the modes and methods of operating the equipment may require examination.

Paper-and-pencil studies usually fail to identify the many correlated factors and interactions, and their cumulative effects on operator performance. The computer model yields both quantitative data and an overall qualitative picture in which even subtle and subjective factors may be recognized.

5.2 User Benefits (Cont'd)

In the earliest design phases, where functional requirements are analyzed and man-machine task allocations are traded off against equipment and system limitations, the trends shown by the model outputs provide an excellent qualitative guide. Even the selection of the TAM's carries its own feedback; their titles and definitions warn the user that a complex and high-workload task is being described as the various command-display sequences are assembled in the model network, and that some form of machine assistance might be necessary. Running the model generates workload stress data on each of the hypothetical operators, such as the visual operator, indicating the nature of a possible problem in terms of unsuccessful tasks or missions.

It is expected that as experience is gained, both the model and the designer's insight into its workings will develop to a point where an almost step-by-step design validation and optimization may be achieved. Even in its early form the model conclusively validated the request to change design specifications on the jet trainer IOS by showing reductions in task time and work stress when the CRT displays were placed close to the operating position. Furthermore, the results of that test indicated in a qualitative way that miniaturization of the IOS, the reduction in equipment size and distances separating controls and associated displays, is desirable in an off-board station from operational viewpoints as well as being desirable in terms of space utilization, particularly in the case of an on-board IOS.

The user of existing equipment may want to analyze the workload presented to the instructor by the IOS interfacing methodology in an attempt to improve the quality of training. The obvious error sources and ergonomic problems are easy to spot but latent workload factors are not. These may rob the instructors of the necessary time to perform teaching tasks. Instructors are usually reluctant to admit that the IOS is getting the best of them and will carry the unnecessary workload by exerting additional personal effort. However, the RTP (or a profile constructed specifically for the tasks in question) will specify the monitoring and assessment tasks required to truly achieve the training objectives and will indicate the high stress levels.

In order to make full use of the capabilities of a modern flight simulator, and the investment it represents, the instructor must be regarded as a major training asset as well as a potential limiting factor. If the IOS interface assists the instructor to take an active part and to exercise positive control over the training session, with sufficient time to monitor and coach the trainee, he/she will contribute significantly to the effectiveness and efficiency of skill development. If the opposite is true, the deficiencies will destroy the credibility of the simulation and cause wasted training time. Even in older devices, updating the IOS and instructor facilities can bring about improved training and trainee evaluation, or as the very minimum, increased utilization of the device and reduction in manpower requirements.

Using the model to identify existing shortcomings in an instructor facility will assist the user in deciding where to apply available funds. The model will compare alternatives and predict the expected improvements in terms of instructor workload or additional training capabilities. A typical trend in this area is to eliminate a second instructor/operator by additional software and IOS equipment; the model will indicate the workloads carried by the eyes and hands of the first instructor and indicate the feasibility of one-person operation.

## 5.3 Recommended Further Work

5.3.1 General. The results presented in this report have been based on a very small sample of experimental data, an equally small ergonomic data base available in the literature, and on approximations derived from past experience where no other data could be found. Nevertheless, the model output seem to be reasonable and the trends logical and consistent with real world predictions. It is important, therefore, to validate the accuracy of the model against real life conditions, and thereby calibrate this highly promising analytical tool for future use.

Further efforts should include the following principal areas:

(a) Validation of model by test under real or realistic operating conditions

(b) Refinements to the input/output interface, using the existing model ports, to include details of human perception and performance parameters

(c) Development of advanced IOS interface methodology and the corresponding TAMs to represent that methodology in the main modelling network.

5.3.2 Model Validation. The validation of the model should consist of quantitative experimental runs, a general exploration of the visual world of the instructor, and specific tests to verify the results produced so far on such input equipment such as the light pen and the light gun. Validation should include the comparison of time allowances used in the RTP to worst-case times in a simulated mission. The approximations used have been based on the experience of a single, highly qualified, instructor pilot. While the basic trends are probably correct as shown, the data base is insufficient to provide reliable results.

An eye point marker device, now available in-house, should be used to investigate the visual world of the instructor, the modes and patterns in which he/she uses displays and other sources of information. This device uses fiber optics and closed-circuit television to superimpose a light beam reflected from the eye pupil onto the background of the visual scene available to the subject. The beam generates a mark which corresponds to the intersection of line of sight with the visual scene, i.e., the principal point of interest at any time. This method would be especially useful to

verify the conditions of visual access and eye-head movements necessitated by the arrangement of the displays relative to the associated controls on the IOS panels. Specifically, the comparison between #1 and #2 configurations would be easily validated by this method.

The eye point marker could generate new data on the relationships that exist between a solid bank of keys or illuminated push buttons, the same equipment arranged in functional groups or isolated by location, and the CRT displays or remote indicator lights associated with them. The model has the necessary input ports, but quantitative data are very scarce.

In addition to being used as an analytical tool, the eye point marker could possibly have application as an input device similar to a light pen.

5.3.3 Model Refinement. The principal input ports to the model, i.e., the TAM networks, were implemented using macroscopic ergonomic or similar data. Since each TAM was first run as a stand-alone SAINT network, this powerful model presented few practical limitations to the depth of detail to which the components of each activity could be explored. Parameters of human performance, cognitive processes and decision making factors were included in the network and quantitative data generated to represent their influence.

Further development of the model would permit analysis of parameters such as color coding, CRT page design, information exchange rate and noise. Combined with data from the eye point marker investigation, this analysis could pinpoint such differences as CRTs mounted in a vertical pattern against a horizontal arrangement where the relative distances are similar but the viewing angles are different.

The types and arrangement of input devices could also be further explored and described in the model. A large solid bank of push buttons is instinctively disfavored, but color coding, local echo response and functional grouping with strong marking produce a workable keypack. The relative merits of these factors could be quantified by the model.

Another area of model development would be to expand and simplify the input/output activity. Designers must make many small inputs in their terminology and they desire quick and simple answers from the model. The basic framework for this ideal model response already exists but the facility of operation will come only with experience and the further definition of modelling terms to the user.

5.3.4 Methodology. The model has the capability to analyze new input/output channels and methods which are coming into use in IOS design. The voice interface and portable terminal devices are two worth further exploration and optimization by modelling.

The technology of speech recognition and voice synthesis has made tremendous strides in the past few years, both in terms of quality and realism of communication and in terms of information transfer capability and accuracy. As part of this study, two existing systems have been examined. One had a vocabulary of 800 words and could handle inputs from four terminals at once.

The other, designed for computer-assisted training of air traffic controllers, can deliver prompting messages and recognize correct answers. The digital system then automatically assesses the trainee operator's perfomance, points out weak areas and recommends remedial training. This facility would deliver an enormous command and teaching capability to the instructors, relieve them of many communications tasks by delivering clearance messages, etc., and even evaluating answers, thereby enhancing the credibility of simulation. While the application of this technique would radically change the IOS philosophy, performance, and workload, the system would remain within the scope of the modelling and analysis techniques developed in this report.

Portable IOS designs and devices are relatively limited in control and display capability at present but further developments are underway. A typical device carries two lines of 12 characters each and has a 20-key keypack with which it communicates to a large instructor support software and display system. The device is slow compared to a keyboard but combined with a lesson plan system where each step represents a complex IOS input, it is adequate to control a training session. Using light-emitting diode or plasma displays, miniature keyboards and a simplified presentation, an enhanced portable unit (perhaps seat-mounted) could be developed. This would permit the instructor to assume the bent position for optimal viewing of the trainee while maintaining a reduced but adequate communication with the IOS.

5.3.5 Conclusion. This study has initiated a new and objective method of evaluation to be applied to the IOS man-machine interface. Further evolution and systematic usage of this powerful tool will enable development of standards and criteria for IOS design and evaluation that will assist the designer to arrive at an optimal system configuration and layout, quickly and accurately.

## ABBREVIATIONS AND TERMS

| | |
|---|---|
| AKB | auxiliary keyboard |
| CAM | crew actions monitor |
| CRT | cathode ray tube |
| ergonomic | of or pertaining to biotechnology |
| IOS | instructor/operator station |
| IOS Activity List | element tasks as related to the use of a given device or function |
| IPTASK | information presentation task: the task describing, in quantitative terms, the display characteristics of a given device |
| ITD | instructor task description: the analysis of typical tasks in terms of information exchanges at the IOS |
| ITL | instructional task list: the list of instructional tasks an instructor may be called on to perform |
| jet trainer | a typical jet fighter simulator, the two IOS configurations of which were utilized for the purposes of this study |
| LVDU | left video display unit |
| RTP | representative task profile: a set of typical training activities arranged to present tasks and workload levels similar to those of a training session |
| RVDU | right video display unit |
| SAINT | systems analysis of integrated network of tasks: a modelling and simulation technique for analyzing a set of problems from the field of human engineering |
| TAM | typical activity module: a description of a typical instructor/IOS activity in sufficient detail so that most task requirements may be matched to most IOS configuration details |
| VDU | video display unit |

# SUPPLEMENTARY

# INFORMATION

AD-A098849

Jul 81

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Brooks Air Force Base, Texas 78235

ERRATA

CAE Electronics Ltd. *Instructor-simulator interface design.* Williams AFB, AZ: Operations Training Division, Air Force Human Resources Laboratory, April 1981. (AFHRL-TR-80-18(I). AD-A098 849)

The computer printouts that were to be included in Appendixes A through J of this report are not suitable for reproduction; therefore, only a single volume will be published. All data resulting from this study are available for inspection at the Air Force Human Resources Laboratory (Contact AFHRL/TSR, Brooks AFB, TX 78235). All mention of Volumes I, II, and III and of Appendixes A through J should be deleted as follows.

Cover: Delete "(I)" following AFHRL-TR-80-48.

Form 1473, block 1: Delete "(I)" following AFHRL-TR-80-48.

Page i: Delete "Volume I" at top of page.

Page iv: Delete "VOLUME 2 (APPENDIXES)" and all subsequent information on page.

Page v: Delete all information on page.

Page 6: At bottom of page, delete "(the entire ITL is available in Appendix A)"

Page 7: In third complete paragraph, line 4, delete "(Appendix C)"

Page 8: At bottom of page, delete "(the entire RTP is available in Appendix B)"

Page 9: At bottom of page, delete "(the entire ITD listing is available in Appendix C)"

Page 10: In second complete paragraph, line 4, delete "(also included in Appendix C)"

Page 11: At bottom of page, delete "(the entire TAM listing is available in Appendix F)"

Page 19: In second paragraph, fourth line, delete "(Appendix H)"

Page 31: In fifth line from top of page, delete "These values are presented in Appendix G"

Page 36: In fourth paragraph, first line, delete "(Appendix B)"

Page 35: In last paragraph, first line, delete "(provided as Appendix A)"

Page 36: In fourth paragraph, first line, delete "(Appendix B)"

Page 38: In last paragraph, fourth line, delete "(Appendix E)"

Page 48: In second complete paragraph, thirteenth line, delete "(Appendix G)"

Page 49: In fourth paragraph, fourth line from bottom, delete "(see User's Guide, Appendix I)" and delete last sentence, "The remainder of the TAMs, and their flowgraphs, can be found in Appendix F."

Page 59: Delete first complete paragraph "The complete set of module flowgraphs, along with the SAINT data for each module, is presented in Appendix D."

Page 63: In third paragraph, first line, delete "(from Appendix F)." In next to last paragraph delete "Data sets for each leg of the RTP are supplied to the User in Appendix D." "The data sets for each of the 19 modules which comprise the RTP are presented in Appendix D under the same MODULE.DAT.

Page 68: In first complete paragraph, fifth line from bottom, delete "(Appendix G)." In last paragraph, last two lines, delete "(see User's Guide, Appendix I, for modification procedure)."

Page 69: In fourth paragraph, second line, delete "(see User's Guide, Appendix I)"

Page 84: In first paragraph, last two lines, delete "(see User's Guide, Appendix I)."

Page 89: In fourth paragraph from bottom of page, second line, delete "(Appendix G)"

Page 98: In second complete paragraph, first line, delete "(Appendix B)." and in second and third lines, delete "Appendix G." (2 places).

Page 99: In third and fourth lines from bottom of page, delete "The results of running the TAMS are shown in Appendix G."

Page 104: In last paragraph, fifth and sixth lines, delete "The parameter sets are shown in Appendix G."

Page 118: At bottom of page delete paragraph, "A description of these tasks can be found by cross referencing the task number with the ITD. A complete printout of the results of RTP leg 3, Configurations No. 1 and No. 2, can be found in Appendix I."

Page 119: In second complete paragraph, first and second lines, delete "(see Appendix J for the full printout)"

Page 164: In NOTE, fourth line, change "opeator" to "operator."

Page 167: In second paragraph, seventh line, delete "(Appendix G)"

Page 197: In second paragraph, fourth line, delete "Appendix G." In fifth line, delete parentheses from "(PARAMINDX)."

E. L. ELLIOTT
Chief, Technical Editing

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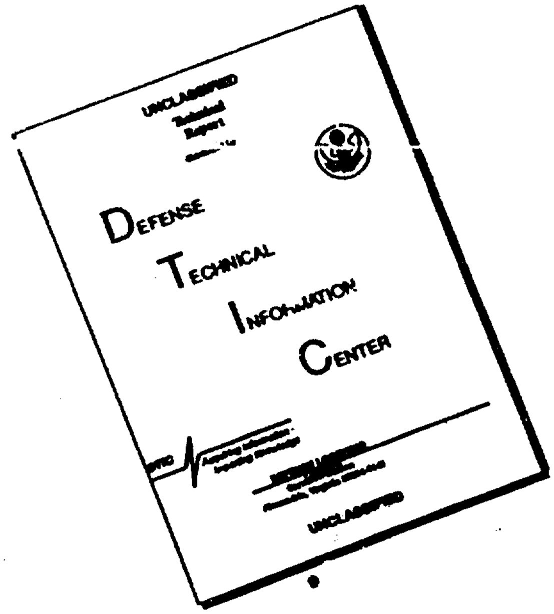


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